Towards Scientific Literacy

by: Frederick J. Thomas and Allan S. Kondo

Published by:
International Institute for Adult Literacy Methods
P.O. Box 1555
Tehran
Islamic Republic of Iran

Available from:
International Institute for Adult Literacy Methods
P.O. Box 1555
Tehran
Islamic Republic of Iran

Towards scientific literacy

Frederick J. Thomas
Allan S. Kondo

Literacy in Development

A series of training monographs

H.S. Bhola, Series Editor

International Institute for Adult Literacy Methods

Literacy in development: a series of training monographs

Series editor: H.S. Bhola
Indiana University at Bloomington,
Indiana, U.S.A.

Cover design: Fred Zimmer

Spanish editions:
Oficina de Educación Iberoamericana,
Ciudad Universitaria, Madrid 3, Spain.

Arabic editions:
Arab Literacy and Adult Education
Organization (ARLO), 1 Shihab Street,
Dokki Giza, Egypt.

French editions:
Conseil Régional pour l'Education et
l'Alphabétisation des Adultes en
Afrique (CREAA), Ministère des
Affaires Sociales, B.P. 1247,
Lomé, Togo.

Titles of *Literacy in Development* training monographs (Series Editor: H. S. Bhola, Professor of Education, Indiana University at Bloomington, Indiana, U.S.A.) include:

Already issued:

The use of radio in adult literacy education, by Richard C. Burke

Programmed instruction for literacy workers, by Sivasailam Thiagarajan

Learning to read and reading to learn: an approach to a system of literacy instruction, by Sohan Singh

The ABCs of literacy: lessons from linguistics, by Kenneth L. Baucom

Towards scientific literacy, by Frederick J. Thomas and Allan K. Kondo

Forthcoming:

Visual literacy in communication: designing for development, by Anne C. Zimmer and Fred. A. Zimmer

Evaluating functional literacy, by H. S. Bhola

Rural public libraries, by E. C. Shaw

The process of primer construction, by Ernest W. Lee

Games and simulations in literacy work, by David R. Evans

Reading materials for new readers: why? what? and how?, by H. S. Bhola

Literacy programmes for adult women, by Marian A. Halvorson

The use of the press in literacy promotion, by Renán Flores Jaramillo

The training of literacy trainers, by Paula Campos de Rozsavolgyi and John W. Ryan

Teaching words and ideas to adults, by Edgar Dale

Planning, organizing and mobilizing for literacy action, by H. S. Bhola

The ABCs of literacy: lessons from anthropology, by Achola O. P[illegible]

The ABCs of literacy: lessons from psychology

Curriculum development in non-formal education, by Anita Dighe, David Kahler and others

The ABCs of literacy: lessons from the policy sciences

Towards scientific literacy

A core curriculum for adult learners and literacy teachers

Frederick J. Thomas,

Lecturer in Science Education,
Riverina College of Advanced Education,
Wagga Wagga, New South Wales, Australia

Allan K. Kondo,

Adviser in Science Education,
Unesco/UNDP Project, Kabul, Afghanistan

Hulton Educational Publications Ltd.,
in co-operation with the
International Institute for Adult Literacy Methods
Tehran 1978

Acknowledgements

The International Institute for Adult Literacy Methods (IIALM) expresses its gratitude to Her Imperial Highness Princess Ashraf Pahlavi for encouragement to proceed with this series and to the Imperial Government of Iran for the material support which has made publication possible. In particular, appreciation is due to His Excellency Mr. Safi Asfia, Minister of State and Chairman of the IIALM's Governing Board; His Excellency Dr. Manuchehr Ganji, Minister of Science and Higher Education, and to Mr Fereidoun Ardalan, Secretary General of the Iranian National Commission for Unesco.

The Institute acknowledges its appreciation to the Series Editor, Professor H. S. Bhola of Indiana University, and to the authors whose efforts he has enlisted. Acknowledgement is also made of the co-operation of the German Foundation for International Development and the German Adult Education Association in organizing a meeting of literacy specialists to review this and other monographs in the series. Special thanks are owed to Dr. Gerhard Fritz and Mrs. Brigitte Freyh, Directors General of the German Foundation for International Development, and to Dr. Joseph Müller of the Foundation's Science and Education Branch.

Spanish editions of the monographs are being published by the Editorial Magisterio Español, for the Oficina de Educación Iberoamericana for which co-operation thanks are expressed to the Secretary General of the OEI, His Excellency Rodolfo Barón Castro. Arabic editions of the series are published by the Arab Literacy and Adult Education Organization (ARLO). For this co-operation thanks are expressed to His Excellency Dr. M. E. Saber, Director General of ALECSO and the Director of ARLO, Dr. El Rawi. French editions are being published by the Conseil Régional pour l'Education et l'Alphabétisation des Adultes en Afrique (CREAA). The Institute is grateful to Monsieur K. Kankpé-Kombath, Permanent Secretary to the Council, for his co-operation in this matter.

Published in 1978 by Hulton Educational Publications Ltd., Raans Road, Amersham, Bucks., in co-operation with the International Institute for Adult Literacy Methods, P.O. Box 1555, Tehran, Iran.

Text set in 12/13 pt Photon Times, printed by photolithography, and bound in Great Britain at The Pitman Press, Bath

ISBN 0 7175 0805 6

Invitation to the reader

Reading a book can be like conversing with a knowledgeable friend. But it is a one-way conversation. The author speaks and his readers listen. Frequently, the author anticipates his reader's thoughts and answers his questions. Otherwise, these questions remain unanswered.

In order to assist the readers of this monograph, the International Institute for Adult Literacy Methods (IIALM) seeks to engage in a genuine dialogue. Today, we live in an age where communications are rapid and not expensive. Therefore, we suggest that the reader send his questions to the IIALM, as well as any problems which might arise. If the Institute itself cannot help, it will endeavour to put the reader in touch with someone who can.

We want to know if you, the reader, are satisfied with this monograph. What we had set out to do was: (a) to create among the readers a more systematic awareness of the natural and the technological environment surrounding us all; (b) to describe how scientific knowledge is created, shared and used to improve human life; (c) to present a set of ideas about man and his environment that will be helpful in interpreting everyday experience; (d) to demonstrate that science is not just the property of the few 'educated' people, but instead belongs to all humanity; and (e) to help bridge the gap between the 'old' knowledge of different cultures and communities—such as folklore—and the 'new' knowledge of international science.

Have we achieved these objectives? The Institute would welcome your verdict.

Write to: Dr. John W. Ryan, Director, International Institute for Adult Literacy Methods, P.O. Box 1555, Tehran, Iran.

Contents

Using science for human satisfactions: notes from the Editor

The love affair between civilization and technology began before recorded history. But today, more than ever before, we are living in a technological age. Also, modern technology is not based merely on trial and error, but on scientific knowledge. We are using science and technology deliberately and systematically to produce more science and technology.

As most of us know, literacy and adult education has been primarily a humanistic rather than a scientific culture. We find little in literacy primers that relates to our scientific and technological environment. In the follow-up literature produced for new literates, again, we find mostly traditional themes. Scientific topics or technological innovations are seldom the subject of attention or concern.

In a way, all this is understandable. Most adult educators are themselves products of liberal arts education. Their own 'scientific literacy' is not always high. Naturally, they find it hard to interpret the scientific and technological environment, either to their co-workers, or to the adult men and women whom they seek to serve through their programmes.

Yet science is impossible to avoid. Science and technology have, indeed, been central to the work-oriented literacy projects introduced by Unesco in various developing countries during the late 1960s and continued through the mid-1970s. Inevitably, the teaching of functional literacy to farmers has involved teaching them scientific agriculture. Teaching of functional literacy to industrial workers has, unavoidably, required the teaching of technology. Functional literacy workers have had to deal with family planning, child-care, nutrition, health and sanitation. In doing so, they have had to teach scientifically supported facts.

Science, however, is not a collection of isolated facts, but the theory or explanation from which these facts derive. Teaching the facts alone is like carrying water by handfuls rather than a bucket. A strenuous effort is needed to transfer a few drops of knowledge, whereas with the 'bucket' of scientific explanation efficient transfer of learning from one situation to

another becomes possible.

It was felt, therefore, that as part of the present series of training monographs, we should go beyond mere facts and procedures. We should deal with substantive knowledge and its structure. Two monographs have been designed, so far, to fulfil these intentions. One of them is to deal with the humanistic culture. It will suggest a core curriculum of humanistic ideas that must become part of a common heritage of adult men and women all over the world. We are aware that absolutes are out of fashion. Yet we believe that such a substantive core of ideas must be presented to adult learners, if not as prescriptions then as topics for discussion. The present monograph, *Towards scientific literacy*, deals with the scientific culture. It suggests a core curriculum of scientific ideas that should become part of the common human heritage. There are those who would object to the presentation of absolutes even in the scientific area. One can, of course, argue that teaching of scientific ideas could easily become the teaching of western ideas. This need not be so. First of all, while the achievements of the west in science and technology have undoubtedly been spectacular, science and technology has always been the most widely shared human enterprise to which all racial and ethnic groups have made contributions over the centuries. Also, in presenting scientific ideas one need not assume a 'holier than thou' point of view. Scientific ideas, as we understand them today, need not be taught at the cost of alternative systems of tribal cultural wisdom, such as folk medicine and yoga.

In preparing a monograph such as this, the authors are compelled to be selective. They begin by discussing scientific literacy within its social context. Their message is that science can no longer be ignored if the aim of literacy is to enable men and women to understand better the world around them. After a discussion of the human environment, the authors consider man himself: his health, his well-being, and his role as producer. Lastly, they examine the man-made technological environment. Each subject is introduced with a list of key concepts and key words and concludes with a number of suggested activities for teaching science in non-formal educational settings.

A final chapter shows how the teaching of science has been handled in functional literacy programmes in Iran and India. General agriculture is the subject area of the Iranian programme and improvement of the health of mothers and children the purpose of the Indian programme.

As in the case of other monographs in the series, the material is addressed to the 'middle-level literacy worker'. In certain cases, the middle-level literacy workers may have to master the material themselves before

they can teach it to field workers, literacy teachers and others. This monograph is not intended as a teaching text for adult learners. Rather, it presents ideas upon which those preparing literacy materials or training literacy staff may build. We hope that this information will be rewritten in different formats for presentation in a variety of instructional settings. The key ideas may be presented on flash cards or embodied in discussion notes, radio scripts and follow-up books. In appropriate form, these ideas may be presented in training sessions for literacy teachers, in field demonstrations for farmers and in literacy classes.

At a time when developed nations are expending huge efforts to disseminate scientific knowledge, it is appropriate that those responsible for literacy programmes in the developing nations consider the need to design programmes which will produce scientific literacy as well as literacy in its classic sense. We hope the material presented here will be helpful in explaining facts already known, in transferring existing understanding to new situations, in more systematically applying learning and experience to everyday life and in developing, generally, a more inquisitive and experimental attitude towards life and work.

H. S. Bhola

CHAPTER 1

The social context of scientific literacy

It has long been recognized that effective work in adult literacy must involve far more than teaching the isolated skills of reading and writing. Much progress has been made in combining literacy with agriculture, industrial technology, child care, health, economics and other fields of knowledge to produce more integrated programmes of basic adult education. However, the task of providing a viable, integrated education for the adults of the world is difficult, and few literacy workers (least of all the present authors) would honestly claim to have found any perfect solutions.

If modern literacy work aims to make adults better able to understand the world around them, better able to communicate about the world, and better able to change the world, then science cannot be ignored. The products of science—radios, motorcycles, medicines, chemical fertilizers, plastic containers and many others—have already become important factors in the daily lives of adults around the world. There is little doubt that science has brought many important benefits. In every nation, for example, the spread of modern medicine during recent decades has dramatically reduced the number of children killed by disease. Modern trucks, motor boats, and other vehicles have reduced the isolation of rural villages. Literacy work itself is dependent upon the technology required to print and distribute large quantities of inexpensive reading materials. In addition to the benefits, however, science has brought new problems. For example, the development of plastics, nylon and other synthetic materials has helped provide better (and often less expensive) clothing, rope and packaging material, but it has made life more difficult for farmers and workers who produce goods made of cotton, silk, wool, jute and other natural fibres.

Much of the material which newly literate adults need to read—perhaps even most of it—is directly related to science. A list of such science-related reading materials might include: instructions for using a new fertilizer, advice on selecting health-giving foods, safety rules for operating industrial machines or household tools, instructions for the use of medicines,

newspaper reports about new government policies on conservation or advice on ways of coping with a drought, flood, earthquake or other disasters.

Few literacy workers are experts in agriculture, automobile repairs, health, mining or other specialized areas. They cannot be expected to be so. But literacy workers must have the ability to communicate with experts and practitioners in these fields. They must also be able to serve as a bridge between those who possess specialized expertise and those who are in need of it.

One type of communication involves receiving and disseminating scientific information. Adults should be enabled, for example, to read and understand the useful scientific information available to them from government agencies, employers and other sources. To cite particular examples, adult education programmes should enable adults both to read and understand the instructions on a bag of fertilizer or the directions on a bottle of medicine.

It should never be assumed, however, that communication in science is only from the 'experts' to the 'ignorant'. An adult who is literate in science should also be able to express himself or herself. If an agricultural extension worker arrives in a village, the adults in the village should be able to tell him about their problems and about their successes. The villagers should also be able to discuss with the extension worker the value and applicability of his suggestions.

Much communication in science involves the exchange of information with experts (such as the agricultural extension worker), but an even more important type of communication may be with peers. Adult education programmes should train people to communicate with each other (both orally and through letters, local newspapers, etc.) about the science-related matters important to them.

Another important type of communication concerns the passing of science information to younger people. It should be remembered that most people learn about farming, child care, health practices and many other things from their parents. Many people learn their occupations in apprenticeships—often from adults with little or no formal education. Adult educators need to be aware that their students play an important role in teaching the young about science-related matters.

Even in the poorest villages, science plays an important part in the life of every adult. Any literacy programme is incomplete if it does not improve the participant's ability to communicate about science. This leads to a basic question: How can science best be incorporated into functional literacy projects?

Perhaps the most obvious place for science in literacy work (particularly for the applied sciences, such as agriculture and health) is as content in reading materials. It is quite appropriate, for example, that posters, primers, follow-up books and other materials include vocational, agricultural or family life information which the readers can use in their daily lives. In this way, literacy materials can help teach some useful science, and the value of the science content can help motivate the readers. Of course, there are many adult learners who are strongly motivated by a desire to read literature or religious writings or to participate in politics, or by other motivations largely unrelated to science. However, for a great many learners, it is essential to provide content from the applied sciences which learners will find useful in their daily lives.

As an idea, the use of science content to motivate reading interests is a good one. There are, however, at least two limitations. One is that relatively few bits of scientific knowledge provide an immediate and direct reward. A taxi driver might, to give one example, find value in suggestions for saving petrol. Similarly, a farmer can see immediate gain in learning of simple ways to control pests attacking his crops. But these examples are the exceptions rather than the rule. Unfortunately, it is seldom simple to improve farming, health or work methods and literacy workers should be cautioned against promising too much from the science information contained in a few posters or pages.

A second limitation with using science to stimulate reading interests is that it develops only one aspect of communication—the transmission of information from expert to non-expert. But adults are *not* ignorant in science. They are already raising crops, raising children and managing their lives. Therefore, one should not begin with the idea that adults have no understanding of science. Instead, adult education should be designed to use and develop what adults already know. The purpose of teaching science is not to pass on a few kernels of information from expert to non-expert, but to enable learners to improve their abilities to communicate in science with experts, with peers and with their apprentices.

Is communication in science any different from communication generally? In some ways it is, although there are many common considerations. One difference is that science often involves a special vocabulary. Scientists, for example, have developed a complex system for naming each of the many millions of chemical substances in the world, and some of these names (such as 'nitrogen' and 'phosphorus' in discussing soil fertility) are important for adult learners to know. Even well-known words (such as 'work') may take on specialized meaning when used in

scientific or industrial literature. Scientific vocabulary can become a particularly serious problem for literacy programmes in languages which lack equivalent terms. This is a problem beyond the scope of this monograph.

Unfortunately, it is not enough to teach the vocabulary of science. The words used in science are often based upon concepts or ideas which a reader must understand to make sense of these terms. The word 'nitrogen', for example, refers to a substance in the air, an important nutrient in the soil, and a component of plants and animals. Before a person can use the word 'nitrogen', he must understand something about how nitrogen changes from one form to another.

To take another example, a person is not likely to understand a poster which warns against drinking 'unclean' water, unless he first understands that many diseases are caused by bacteria which are too small to see. Water which looks clear might still contain dangerous bacteria, and thus be 'unclean'. All adults have their own ideas about matters such as human disease, but it may be necessary to help them improve their understanding of these concepts by supplying additional information.

Another important characteristic of communication in science is that knowledge should be based upon solid evidence, not just on personal authority. Whenever someone writes or speaks about some area of science, he should consider the question, 'How do I know this is true?' Similarly, when someone reads or hears a scientific statement, he should think, 'Why should I believe this?' In many cases, of course, we believe a scientific statement because we trust the person making it. But, in science, the listener always has the right to ask for proof.

Thus far, it has been suggested that the teaching of science should have an important place in literacy work. First, teaching which relates to occupations and physical well-being will usually be incomplete if science content is not included. Secondly, in order to communicate about the world around them, adults must learn to use concepts and terms from science accurately and comfortably. Thirdly, because the adult learner already possesses many scientific concepts and understandings, the teaching of science can proceed through dialogue and discussion and can expand and develop existing knowledge. Fourthly, because science involves the careful examination of concepts and facts, it should lead toward a critical analysis of other aspects of life: a fundamental goal of education. Finally, science by increasing individuals' understanding of their environment permits them the possibility of controlling some aspects of the environment and changing it in ways that they desire.

This monograph is based upon three assumptions:

1. *Adults already know a great deal about the areas of science which are important to them.*
2. *The primary aim of science in adult literacy programmes should be to help adults improve their ability to communicate (not only through reading and writing, but also through other media) about science-related matters.*
3. *The development of science communication requires the building of a science vocabulary, an understanding of basic ideas or concepts and the development of certain values regarding the evidence for scientific beliefs.*

The rest of this monograph is intended to suggest ways in which some of the basic words, concepts and values of science can be introduced to adult learners. Since the monograph is intended for use in many different countries, not all examples will be relevant to everyone. For example, hurricanes and typhoons are mentioned here, because it is important for people living on islands and in coastal regions to understand storm warnings when they are issued. On the other hand, hurricanes and typhoons are of little direct importance to people in most inland regions. An effort has been made to select topics and examples which will be familiar to the largest possible number of people, but users of the monograph must recognize the need for adapting it to the climate, crops, health problems and general concerns of their region.

It is strongly recommended that the users of this monograph make every possible effort to relate it to local conditions. A good way to start might be for the user to examine carefully some of the materials currently available from local agencies concerning health, agriculture, business, transportation, manufacturing, etc. What words and concepts does a person need to understand in order to read the materials? What are some of the scientific words which occur frequently in local newspapers? What concepts from science are important to people in their work? The goal is to involve the learners in activities which will promote their ability to use these words and concepts.

In brief, the monograph is intended to present a 'core of scientific ideas about man and the technological environments in which he lives'. It is hoped that the text will also demonstrate that science can be simply presented and that the suggested teaching exercises will reveal the manner in which science cannot only be taught, but practised in modest ways. Finally, the monograph makes certain suggestions about the teaching of

science in non-formal educational settings and provides two examples of how science has been incorporated into literacy programmes and used to further man's understanding of agriculture, in one instance, and health in the other.

Towards scientific literacy consists of short chapters on a variety of science topics. Each chapter has been developed around a few key concepts and words from science, and these concepts and words are listed at the beginning of the chapter. Within each chapter, the concepts and words are explained as simply as the authors could manage. Each chapter ends with a list of 'suggested teaching activities'. Most of these activities ask the learners to go beyond the information presented in the chapter, to apply the concepts and words in examining their own immediate environment. In one chapter, some illustrations are provided on presenting scientific material to adult learners. The monograph is not intended to be used as a text. It seeks instead to provide literacy personnel with an understanding of certain scientific concepts which may be useful to them in preparing literacy materials and training instructors and other staff.

CHAPTER II

An introduction to science

Who is a scientist?—How to do an experiment

A. WHO IS A SCIENTIST?

Key concepts: *Anyone can be a scientist. Scientists are persons who try to understand the things around them.*
Key words: *Science, scientist, observe, understand, predict, control.*

Science is the study of real things—for example, soil, plants, animals, machines, automobiles, radios, food, wind, rain and even people. Science studies everything which you can see, hear, touch, smell or taste. Scientists are people who try to understand the real things around them.

Religion and philosophy are two areas which study things you cannot see or touch directly. Sometimes science may seem to be in conflict with religion or philosophy, but this need not be so. Many scientists are deeply religious.

Everywhere in the world there are people who look carefully at the things around them and try to understand what they see. Any person who does this is a scientist, even if he or she never studied science from a book. There are good scientists in every country in the world. There are scientists in cities, in small towns, and in the most remote rural areas.

The first thing a scientist does is to observe. Many people walk past things without really seeing them, but a good scientist looks at things with care. For example, some people might look at a field of maize and only see the maize itself, but a good scientist would look more closely. Growing among the maize he might see many other kinds of plants. He might see many different insects, and perhaps he would see that some of the insects were damaging the crop, while other kinds of insects were harmless. A good scientist would notice the condition of the soil, and he would notice which plants

are healthy and which were not.

Other scientists study automobiles and learn to notice the differences in the engines of various cars. A woman shopping for food is a scientist when she observes with care which fruits and vegetables are best and which are defective. Besides using their eyes to observe, scientists also use their hands and their ears and even their senses of smell and taste. No matter what he or she observes, a good scientist has learned to examine things with care.

The second thing a good scientist does is to try to understand what he or she observes. For example, when a farmer sees small holes in the plants in his field, he may try to understand exactly what caused the holes. If he is a good scientist, he may prod the hole, and perhaps find an insect which has burrowed inside. When a scientist hears a strange noise coming from an automobile engine, he will try to find out what is causing the noise. When a mother sees her children become sick, she tries to understand why—perhaps it was because they drank dirty water or ate some bad food. A good scientist is always trying to understand why things happen. There are many other things which scientists cannot yet understand, but they are always looking for natural causes for the things they observe.

The third thing a good scientist does is to predict. Some people are very skilful at watching the sky and predicting when it will rain. Some people can listen to an automobile engine and predict whether or not it will break down soon. Some traders are skilled in predicting just when fruit will ripen or spoil, so they know the best time to buy and sell. In most cases, people can make these predictions because they have had experience and know what has happened in the past. Predicting is sometimes difficult, and people who try it may make mistakes. Even the best scientists cannot always be right when they make predictions. On the other hand, people who observe things carefully and learn to understand them can often make predictions which are right most of the time.

Science is not like magic or superstition. Some people try to make predictions based on magic, but a scientist makes predictions based on what he sees and knows. For example, when a farmer plants some seeds in his fields he may be able to predict how many days later the young plants will break through the soil. If the farmer's prediction is based on his past experience and on his understanding of the soil, the moisture, the weather and the seeds, then he is a scientist, not a magician.

The fourth thing scientists do is to control. A good farmer, for example, may know that seeds sprout more quickly when they are moist. If he wants the seeds he plants to sprout quickly, he may be able to make them do so by soaking them in water. If he wants to stop his seeds from sprouting (for

example, when he stores them before the planting season), he can do so by keeping them dry. Because he understands what makes seeds sprout, a farmer can control when they sprout. The person who is a good farmer and a good scientist has learnt many different ways of controlling his crops, to help make them grow the way he wants.

A person who understands automobiles may also be able to control what they do. For example, a man who hears a certain noise coming from an engine may predict that it will soon break down, but he may also be able to repair it and prevent it from breaking down. In the home, a woman who understands how to cook well can control the food so that it tastes just as she wants. Parents who understand what causes disease may be able to keep their children healthy. Scientists cannot control everything. A serious drought, a worn-out car or a serious illness may be too much for anyone to control. Still, if a person understands something, he can often control it.

Some people spend their entire lives studying science. For example, many people have spent years and years watching birds, trying to see how they fly, how they find food, or how they reproduce. Other people have spent years studying a single kind of insect, trying to learn everything they can about it. People have spent years studying different kinds of rice, trying to learn what makes it grow well. Often a large group of scientists will spend many years studying a single disease, trying to understand what causes it and how it can be treated or prevented. Many of the people who study science work in universities or government agencies, but there are thousands of people with ordinary jobs who also study science. Almost any object imaginable has been studied by someone.

Consider mosquitoes, for example. Mosquitoes are troublesome because they make people uncomfortable, and because they can carry malaria and other serious diseases. Many people have worked hard to learn all they could about mosquitoes, and after all those years of work they have learnt quite a lot. By watching mosquitoes, for example, people now know that mosquitoes lay eggs in water, the eggs hatch into tiny 'worms', and later the 'worms' change into mosquitoes. People have also learnt several different ways of controlling mosquitoes. One way is to remove the water from the places where mosquitoes lay their eggs. Another way is to spray an area with a poison to kill either the 'worms' or the mosquitoes.

A good scientist tries to observe, understand, predict and control. The fifth thing he does is to share what he learns with others, usually by writing about it in a book, a magazine or a newspaper. If you want to learn something about mosquitoes, rice, automobiles, diseases, food or some other subject, you do not necessarily have to spend years studying it for

yourself. You can read what other people have learnt in their years of work and study.

Suggested teaching activities

1. *If possible, adult learners should be shown an encyclopedia. Let them name topics and see what the encyclopedia has to say about each one. The point is that there is written information available on almost any topic which might be of interest. Have them discuss how the people who wrote the encyclopedia learnt what is written there.*
2. *Have adult learners discuss or write about these questions*
   a. *Are you a scientist?*
   b. *Who is the best scientist you know personally?*
   c. *Who do you know who is skilful at making predictions? How does he or she make the predictions?*
   d. *If you could spend an entire year studying one thing, what would you study? How would you begin? Has anyone else studied it already?*
3. *Have them make some predictions about future events, and discuss whether or not the predictions are scientific.*
4. *Bring an object into the classroom (for example, a shirt, a plant, a piece of furniture, or almost anything else) and have each person write a careful description of what is observed. Have the group discuss the descriptions. Have them discuss why it is different people observed different things.*
5. *Many countries have magazines or newspaper sections in which amateur scientists publish what they learn. If such a magazine or newspaper is available, have the adult learners examine and discuss it.*

B. HOW TO DO AN EXPERIMENT

Key concepts: *Anyone can do experiments. An experiment is a way of testing new ideas.*
Key words: *Experiment, compare.*

After a person understands something, he or she may have an idea about

how to make it better. A good scientist would test the idea by doing an experiment. An experiment is a way of comparing two or more things.

For example, a farmer may believe that he can improve his harvest by adding lime to his soil. He could simply add lime to his entire farm, but that might not be a good thing to do. If he is wrong and the lime does not help, his crop may be worse than before. If the new crop does grow well, it will still be hard for the farmer to be certain whether the lime helped, or the good harvest was a result of plentiful rains or some other condition. A safer, more accurate method is to do a simple experiment or compare the new method with the old one. The farmer could obtain a small quantity of lime and use it on a small plot next to his regular crop. The soil should be the same as his regular fields and the crops should be treated in a similar way—except for the lime. When he is ready to harvest the crop, the farmer can compare the two plots and see for himself which method is better. If the new method is better, the farmer may calculate whether or not the improvement justifies the cost, and if it does he may go ahead to use the new method on his entire farm. If the new method does not work, he will have only lost the harvest from a small plot.

By doing simple experiments, a farmer can learn for himself what methods are best. He can test different kinds of seed, and he can try different farming methods. For example, how close together should seeds be planted? How deeply should they be planted? The answers to these questions depend on the crop and on the local conditions, but a farmer can find the answers by doing experiments. He could conduct experiments on different ways of preparing the soil, on different methods of fertilization, on different times of planting, or on many other things. All he needs is an idea about how he might improve his crops and a small plot of land on which to test the idea. He should select a plot which is much like the rest of his farm, and he should treat it in exactly the same way he treats the rest of the crop, except for the one idea he is testing.

It is important in doing an experiment to test just one idea at a time. Suppose a farmer has two ideas: (1) he thinks he can get a larger harvest by planting his seeds closer together, and (2) he thinks he can get a larger harvest by using more fertilizer. If he does both things at once (planting his seeds closer *and* using more fertilizer), then he will not be able to tell which idea really worked. Maybe the fertilizer helps, but planting the seeds closer together does not help. The best way to test the idea may be to do *three* separate experiments: (1) plant the seeds closer together but do not add extra fertilizer, (2) add extra fertilizer but plant the seeds the normal distance apart, and (3) plant the seeds closer together *and* use extra fertilizer.

He can compare each of the different methods with his regular crop and with each other. This way he can learn which method is best—the old method, or planting the seeds closer together, or using extra fertilizer, or doing both at once.

People everywhere can do experiments. Anyone who has an idea on how to improve something should do an experiment to test the idea. Perhaps a tailor has an idea for a way to sew stronger seams. If he does, he should try the new way and compare it with the old way to see which is really stronger. If a wife has an idea for a better way to store her family's food without spoiling (for example, by putting it in a cool place) she can do an experiment to see if the new idea is really better. She could store some food in the new way and some in the old way, and see for herself which stays fresher longer.

Scientists are interested in seeing what happens. Some people tend to believe that only the old ideas are good. Some people seem to believe that only new ideas are good. A scientist does not care whether an idea is old or new. He wants to see for himself which is better.

An experiment is one way scientists learn more efficient ways of doing things. When a good scientist learns something, he tells other people what he has learnt. A farmer or a wife may tell their neighbours about their experiments, or they may write to a newspaper or magazine to reveal to even more people what they learnt. Governments hire some scientists to spend all their time doing experiments, testing new ways of doing things. These scientists write about what they learn, so everyone can use their ideas.

Suggested teaching activities

1. *Find a description of an interesting experiment conducted by government agricultural workers, by home economists, or by someone else, and have the adult learners read and discuss it.*
2. *Have the adult learners discuss or write about these questions—*
   a. *Do you believe a farmer should use a small plot of land on which to do experiments?*
   b. *What new ideas do you have about how to do something in a better way? How could you do an experiment to test your ideas? Do you suppose anyone else has already tried the same experiment? If your idea works, would other people be interested in reading about it?*

CHAPTER III

The environment

Weather—Rain—Storms—Controlling weather
Soil erosion—Space

A. WEATHER

Key concepts: *Weather can be predicted. Attempts have been made to control it: over small areas the effects of the weather can be controlled.*
Key words: *Weather, meteorology, meteorologist, observe, understand, predict, control.*

The study of weather is probably one of the oldest and most common scientific activities. For thousands of years, people everywhere in the world have observed the changing weather, and they have tried to understand it. They have tried to learn what causes rain and drought, why we have thunder and lightning and storms, or what is the reason for hot and cold weather. Farmers and fishermen are especially dependent upon the weather. A good farmer must be able to do his ploughing, planting, harvesting and other activities at the correct time to take best advantage of the rains, sunshine and good temperatures. Fishermen also need to be astute observers of the weather, since if a sudden storm catches them unprepared they may lose their lives. It is not surprising that some of the best forecasters of local or regional weather conditions are farmers and fishermen.

Weather can be defined as 'the condition of the air'. Four of the most important parts of the weather are temperature, wind, moisture and sunshine. Moisture is probably the part of weather which people notice most, especially when it comes in the form of rain or snow. Another word for the

study of weather is 'meteorology', and a person who studies the weather is a 'meteorologist'.

Observation and practical experience are important in studying weather. One who wishes to understand weather well would also want to read about the subject to get more knowledge. Although a great deal is now known about the cause of weather, there is much which is unknown. No one, for example, understands completely the causes of lightning.

The first thing every good meteorologist does is to observe the weather. The second thing he does is to try to understand what he observes. The weather is often difficult to understand. For example, it is much easier to see that it is raining than it is to understand exactly what causes rain.

Another thing which good meteorologists try to do is to predict the weather, to be able to say in the morning that it will rain in the evening. Some of the best predictors of weather are farmers, fishermen and other ordinary people, who may have little education but who still have valuable experience. Perhaps they have learnt that a certain kind of cloud often goes before a storm, or that when the wind blows in a certain direction the weather is usually dry. Good predictors of the weather notice dozens of different signs, and use their experience to predict what will happen. Predicting the weather is difficult, and even the best weather prophets can make mistakes.

In most countries, there is a national weather service which observes the weather and issues forecasts. These are especially important when they warn of a coming storm, which might bring damaging winds or floods. If people are forewarned, they may be able to save their possessions, their homes or even their lives. Those working in weather bureaux use many of the same methods as do ordinary people in predicting the weather. They observe the wind, the clouds, the temperature, and many other things, and they use their experience and knowledge to interpret these signs. Men and women of the weather service, however, have a big advantage. They can communicate by telephone or radio with people who observe the weather in other cities and towns, on ships at sea and in aeroplanes. Sometimes people in these places report a serious storm, and the predictor may know that the prevailing winds will blow the storm towards his region.

Meteorologists observe the weather, attempt to understand it, and endeavour to predict it. Sometimes meteorologists also try to control the weather. Men and women have long dreamed of controlling the weather. During droughts, people have tried to make it rain. During floods, people have tried to stop the rains. One way meteorologists have tried to make rain is by flying aeroplanes into the clouds and dropping tiny pieces of ice.

People have also attempted to make rain by burning different substances so that smoke rises into the clouds. The meteorologists had the idea that a drop of rain might form around each piece of ice or each speck of dust in the smoke. Unfortunately, most of these experiments have failed. Even if an experiment seems to work on one occasion, it often fails the next time. Meteorologists are still trying to control the weather, but so far they cannot do it on a large scale. On the other hand, it often is possible to control the effects of the weather on a small scale. The farmer who irrigates his fields or provides shade for his crops is, to a certain extent, controlling the weather but only where the plants are growing. Sometimes farmers build small plastic covers over their plants, to keep them warm and moist when the air outside is cold or dry. In fact, anyone who builds a house is actually producing a small space over which he can control the effects of rain, temperature, wind and light.

Suggested teaching activities

1. *Have the adult learners discuss these questions—*
   a. *Are you a meteorologist?*
   b. *What things do meteorologists do?*
   c. *What person do you know who is good at predicting the weather? Ask him how he does it.*
   d. *What kind of weather do you like best? Do you know a place where the weather is pleasant even when it is unpleasant in other places?*
   e. *If you feel too hot, what can you do to feel less uncomfortable? Is this a way of controlling the weather?*
   f. *What can farmers do to control the effects of the weather in their fields?*
   g. *Where do housewives or traders store food to keep it from spoiling? Is the weather in those places hot or cool? Is it moist or dry?*
2. *Provide the adult learners with detailed information about how they can learn of storm warnings from their national weather service. Give actual examples, and have the learners discuss what they would do to prepare for a dangerous storm.*

B. RAIN

Key concepts: *Water comes and goes in a cycle. Water can never really be created or destroyed.*
Key words: *Cycle, water vapour, evaporation, condensation, snow, hail.*

Sometimes scientists study weather because they want to predict it or control it, but scientists may also study something only to understand it better. At some time in the future, this understanding may have practical benefits (since if we understand what causes the weather we can predict and control it better), but many scientists work just because they are curious. The curiosity of scientists is similar to the curiosity of any man or woman, who might watch the rain falling and wonder where it comes from. It almost never rains without clouds, so part of the answer is that rain comes from clouds. But a scientist—or any curious person—may not be satisfied with this answer. Other questions are asked: What are clouds really like? Why do some clouds bring rain, while others do not? Where do clouds originate? If people are curious enough, they may try to find answers to most of these questions. Perhaps a person will see that the top of a mountain is actually in the clouds, and climbs up the mountain to see what the inside of a cloud is like.

By doing different experiments (such as flying aeroplanes into clouds to collect 'pieces' of them), scientists have been able to answer many questions. A cloud is similar to fog, except that clouds are high up in the sky. They are made up of minute drops of water (or, sometimes, tiny pieces of ice). The drops are so small and light that the wind keeps them from falling to the ground. In some clouds, the drops never fall, but in other clouds the drops keep getting bigger and bigger until they grow so heavy that the wind cannot keep them suspended. Then, they fall to the ground. When the air is warm, they fall as rain. When it is cold, they fall as snow, sleet or hail. Even when the air near the ground is warm, the air up in the clouds may be acutely cold. Even in the tropics, the air up in the clouds is sometimes cold enough to make hail.

But where do clouds come from? They come out of the air by a process called condensation. Sometimes you can see this process taking place on a cold surface, such as on a cold bottle of beer or soft drink. If you let the bottle stand for a few minutes in the air, the outside may become wet with water. This water was already in the air as a gas, called 'water vapour', even though you could not see it. All air contains some of this water vapour, but sometimes (especially in desert regions) there is not much of it.

When there is only a little water vapour in the air, everything exposed to the air dries more quickly and people may notice that their skin, lips and throats feel dry. Other times, there may be excessive water vapour in the air, even if you cannot see any clouds. Then, the air often feels 'stuffy' or 'steamy', and if a person sweats, the sweat may stay on his skin and make him wet and uncomfortable.

A good scientist might ask another question: If rain comes from clouds, and clouds come from water vapour, where does water vapour come from? The answer is that it comes from the 'evaporation' of water. If a pan of water or a piece of wet clothing is left exposed to the air, it will dry. The water in it seems to disappear, but actually it has gone into the air as invisible water vapour. When water 'evaporates', it changes from liquid water into a vapour. Evaporation is the opposite of condensation. Most of the water vapour in the air comes from the oceans. These vast areas of water, which cover more than half the earth's surface, are constantly evaporating into the air. Thus, we can say that rain comes from the seas.

Water from the oceans evaporates into the air, just as water from a pan or a piece of wet cloth evaporates. This vapour may rise high into the air where the air is much colder. When it gets colder, it can condense to form drops of water, just as water condenses on the outside of a cold bottle. The drops of water up in the air are what we see when we look at clouds. A cloud is made of tiny drops of water. Winds can blow these clouds from the oceans over the land, sometimes for hundreds of kilometres. Eventually, if the drops become large enough, the water from the clouds may fall to the ground as rain, snow, sleet or hail.

The winds that bring the clouds and water vapour are one of the most important causes of wet and dry seasons. If during part of the year the wind blows from the ocean on shore, there may be be frequent rains and even monsoons. At other times, if the winds blow from another direction, the weather may be dry. Some parts of the world where winds from the oceans seldom reach (perhaps because they are blocked by mountains) may be deserts. In other places where the wind almost always blows from the ocean, there may be rain forests.

A curious scientist may still not be satisfied to know that rain comes from the oceans. He might ask: if rain comes from the oceans and the oceans are constantly evaporating, then why don't they dry up? In other words: Where does the water in the oceans come from? Much of it comes directly from rain (since it rains over the oceans too), but some of it comes from rivers. Almost all the rivers in the world eventually flow into the oceans. (A few rivers do not flow into the oceans, but instead either pour

into a lake and evaporate or simply evaporate directly before reaching the lake.)

A curious person might next ask: where do the rivers come from? The answer is: FROM RAIN! Much of the rain that falls runs off into streams, and the streams come together into rivers, and the rivers come together into larger rivers which eventually carry the water back into the oceans. Even water which sinks into the earth may flow through the soil and rocks, and later come out again at a spring or well. After a time, the water which falls on the land either evaporates into the air or it flows back to the ocean.

Water constantly flows into the oceans, evaporates to form vapour, condenses to form clouds, falls to the earth as rain, and flows back again into the oceans. The water keeps going around and around in what scientists call the earth's 'water cycle'. The water which falls as rain is not 'new' water; it is the same water that has been falling and flowing and evaporating and condensing for millions of years. In a single drop of rain, there may be water which has fallen before on Africa, Asia, North America, South America, Europe, Australia, and even Antarctica. The entire earth is tied together in one water cycle.

Water cannot really be destroyed. We can use it, make it dirty, freeze it into ice, or evaporate it into vapour. We can make it combine with other things so it seems to disappear, as when we cook rice in water. We can drink water, so it becomes part of our bodies and blood. Plants also 'drink' water through their roots, and they change some of that water into oxygen (a gas in the air). In spite of all these changes, water can never be totally

destroyed. The water we drink and use in our bodies eventually passes out again as urine, sweat or water vapour in our breath. All water eventually returns to the ocean.

Water cannot be created from nothing. The world has just a certain amount of water (mostly stored in the oceans, seas and lakes), and we must use it over and over again. The earth's water is essential to life and it needs to be used carefully.

A cycle is a process which goes around and around, seemingly without beginning or end. There are many other cycles in nature in addition to the water cycle. The oxygen we breath to live is also in a cycle which links together plants and animals and men. The minerals (or fertilizers) which plants need are also involved in a cycle of being removed from and returned to the soil.

Suggested teaching activities

1. *Bring a cold bottle or a glass of ice water into the class and let water condense on it. Have the learners discuss where the water comes from. (Try this first to see if it will work! If the air has too little water vapour or if the bottle or glass is not cold enough, no water will condense.)*
2. *Use a large map to show the rivers and seas, and have the adult learners discuss—*
   a. *How could rain and clouds reach your town or city from the ocean? (This may be difficult to determine, because winds sometimes blow moisture over long, complicated paths.)*
   b. *When it rains and water runs off into streams and rivers, what route does water from your area follow back to the ocean?*
3. *Have the adult learners discuss the direction of the wind in their location at different seasons. Could the direction of the wind explain why one season is dry and another is wet?*

C. STORMS

Key concepts: *Storms are natural phenomena which scientists are trying to understand. Scientists can often predict storms, and some day they may be able to control them.*
Key words: *Lightning, hurricane, typhoon, tornado.*

There are many different kinds of storm. Sometimes a large storm may cover hundreds of kilometres. At other times, a storm may be so small that it produces heavy rain in one place and no rain a short distance away. Some storms produce rain, snow, sleet, hail, or several of these at once. Sometimes a storm is accompanied by strong winds, but little or no rain. Other storms have heavy rain, but little wind. The most dangerous storms are hurricanes, typhoons and tornados. Hurricanes and typhoons are gigantic storms which form over the ocean and move over huge areas bringing torrential rain and strong winds. Hurricanes and typhoons are similar, except that 'typhoon' is used for such storms in the Western Pacific region. A tornado is a 'mini' storm in size (sometimes measuring only a few metres across), but it is extremely dangerous. A tornado is a powerful whirlwind which can destroy almost anything in its path.

No one really understands exactly how storms are formed. Lightning, for example, remains something of a mystery to scientists. They know that it is a form of electricity, just like the electricity from the electricity points or from batteries in a torch or radio. Of course, the charge of electricity in a single flash of lightning is powerful enough to split large trees into pieces or to set fire to buildings. Lightning is a giant electrical spark which jumps between two clouds or between the clouds and the earth. Objects which are closest to the clouds, such as tall trees or high buildings, are most likely to be struck by lightning. Lightning causes thunder, by heating the air in its path so much that it expands and crashes into the air around it. But what causes these giant electrical sparks? Somehow, storm clouds can act like giant batteries, but so far no one understands exactly how it happens.

Scientists do know that almost all storms, large or small, are caused by variations in temperature. A storm almost always involves a decrease in temperature. Sometimes this decrease is so great that when a storm breaks you can actually feel the air around you becoming much cooler. Other times, the drop in temperature is so small that it is not noticeable. Basically, every storm begins when the air containing water becomes cooler.

Large storms usually occur when a massive current of warmer air containing water runs into cooler air. Often the warmer air is coming from the oceans near the tropics, and the cooler air from places nearer the north or south poles. By the time the two currents of air meet the difference in temperature may be small, but it can still cause a big storm. The warm air becomes cooler, and just as water vapour in the air condenses on the outside of a cold glass or bottle, the water vapour high in the air condenses to form clouds and perhaps rain or snow. Sometimes there is little wind with

these big storms, but at other times the warmer and cooler air begin to swirl around producing winds.

Scientists are trying to understand storms. They can sometimes predict them in order to give people time to move out of the path of a storm. If people receive a few hours' warning and prepare for a hurricane or typhoon, thousands of lives can be saved. Scientists are also trying to find ways of controlling dangerous storms, perhaps steering them away from populated areas, but they have not yet succeeded.

The wind and rain from a storm can destroy crops, roads, homes and lives. Often the greatest danger comes from floods which often follow heavy rain. To be safe from storms, people need to plan how they can protect their families, their property and themselves.

Suggested teaching activities

Have the adult learners discuss or write about these questions—

1. *What was the worst storm you can remember? What damage did the storm do? If people had prepared for that storm before it came, what could they have done to protect their lives and property?*
2. *If a storm comes to your region, where is the safest place to stay? What places in your region are sometimes covered by water in a flood? What places are sometimes struck by lightning?*
3. *If you were warned that a serious storm was coming in a few hours, what would you do to protect your home and family?*
4. *How can you know when a serious storm may be coming? Are warnings broadcast on the radio? Are warnings given in other ways?*

D. CONTROLLING WEATHER

Key concepts: *There are different ways of controlling the effects of the weather on a small scale.*

Key words: *Temperature, moisture, wind, sunlight, windbreak, irrigation, ventilation.*

Sometimes people believe the weather cannot be changed. A farmer who sees his crops being destroyed by drought may do no more than curse his fate. When cattle, chickens, or other livestock become sick through a period of bad weather, which is either too hot or too cold, farmers may feel helpless to do anything for their livestock. A trader whose goods are ruined by rain may blame his troubles on bad luck.

It is extremely difficult to change the weather on a large scale. For example, people have tried many experiments to bring rain during a drought, but almost all of the experiments have failed. On the other hand, it often is possible to control the effects of the weather in a small way.

Weather can be considered as consisting of four parts—temperature, moisture (including rain, snow, water in the soil, etc.), wind and sunlight. Each of these changes greatly from season to season and from day to day; they also change within small areas. For example, on a windy day you can find some places where the wind is much reduced. Trees are good at slowing down the wind, so a person standing in a grove of trees will almost always find less wind than a person standing in an open field.

In many parts of the world, wind is a serious danger to crops, livestock, and even homes and people. The wind may damage crops directly by bending and breaking them, but it also can damage them indirectly by causing them to dry more quickly. Wind can also cause serious erosion, actually blowing away the soil.

Can wind be controlled? No one knows how to stop the wind from blowing entirely, but many farmers do protect their crops by planting trees and building barriers around their fields to break up the wind. The value of trees as a windbreak, the best kind of trees to use, and the best location to plant them all depend on the local situation. But this is one way a farmer can partly 'control' the wind. People who live in areas where strong winds create problems have often developed many different solutions.

It is bad to have too much wind, but it can also be bad to have too little wind. Sometimes people live and work in buildings which are almost entirely closed. If the air cannot move in these buildings, they tend to be uncomfortable and become unhealthy. Heat, smoke, and bacteria may all be trapped inside the building. Every building needs some ventilation, or way of producing a small 'wind'. One of the easiest ways is to have two open windows, on opposite sides, so that some wind can pass through. If there are fires inside the building for cooking or heating, then there needs to be a chimney or other opening, through which smoke can blow away. Even in cold weather, people need to be sure that some fresh air comes into their homes. Animals also need fresh air. Whenever livestock are kept in a

building or are moved in a truck, they need ventilation.

Moisture is another part of the weather which can often be controlled. A good trader knows many different ways of keeping his goods dry, both while storing them and while transporting them. Some goods, such as fresh vegetables, may need to be kept moist, since they may be worthless if they dry out too much. Often, goods are sealed in water-proof packages, made of metal, plastic, or glass, so the moist things stay moist and the dry things stay dry. No matter how he does it, every trader has to know how to control moisture, or it can destroy his goods.

Farmers are also greatly concerned with moisture. To the plants in a field, the most important moisture is in the soil. Even if the top of the soil is hot and dry, plants normally grow well, as long as their roots stay cool and moist enough. One way to control the moisture in the soil is by irrigation—getting water from somewhere and letting it run on to the field. In some locations, irrigation is not necessary, and in other places it is not practical. In places where it is both needed and practical, it can often increase farm production very dramatically.

In many places, soil is too moist. Most farm crops do not grow well in swampy or marshy areas, because there is too much water around their roots. In this case, farmers can sometimes dig ditches to drain away the extra water and so assist crop cultivation and production.

If the soil is too dry but irrigation is not practical, there are still ways of controlling the moisture content. One method is to keep the soil covered with something—perhaps living grass or a layer of dead plant foliage. Soil thus covered is protected from the wind and sun which may dry it out. There are also special techniques of ploughing to help control moisture. The local agricultural service should be able to provide advice on controlling soil moisture.

Another part of the weather which farmers sometimes control is sunlight. Most crops need a lot of sunlight, but some can be damaged by too much sunlight. For example, an experienced farmer may know that certain crops grow best if he plants them where they have sun in the morning but are shaded from the strong afternoon sun. Sometimes farmers build something to protect their crops from too much sun. They may plant certain crops under trees, or sow two crops together so that one shades the other. The experiences of farmers and scientists have brought forward many ways of controlling the effects of sunlight.

Not only crops but many other things can be damaged by too much sunlight and need to be protected from excessive light. Coloured fabrics, for example, may fade if left in the sun too long. Farmers often need to

build a place where their animals can find shade. Even people need to be protected from the sun, since their skin can be burnt by too much strong and bright sunshine.

Temperature can also be controlled. When people are too hot, they may fan themselves or find a cool, shady spot. When someone is hot with a fever, a wet cloth on the forehead may bring the temperature down. When people feel too cold, they can build a fire for warmth, or put on extra clothing. Cattle, sheep, chickens and other livestock also need to be protected from weather which is too hot or too cold. Not many people would put protective clothing on their livestock, but it is important to provide warm shelter when the weather is cold and to ensure shade, ventilation and water in hot weather.

Some farmers regulate the temperature in their fields by covering plants with sheets of plastic. The plastic lets the sunlight reach the plants, but still keeps them warm when the temperature outside may be too low. Many plants can be killed by a single cold night, especially if frost forms, so some farmers cover their plants with baskets or other things when they believe the coming night may be too cold. Many farmers in colder regions also make hothouses of glass or plastic, and they may use them to start plants early in the season, before the weather is warm enough for growth in the open.

Foods can easily be ruined by the excessive temperatures. If meat, fish, milk, vegetables or other foods are kept in a warm place for too long, they deteriorate and may even become poisonous. There are many different ways of preserving food, but one way is to store it in a cool place. Food lasts longer in a cool place, but it will still 'go bad' if stored too long. Most people also prefer cool drinking water, and they store their water in earthenware containers or in special cloth bags to keep it cool.

Sunlight, wind, moisture and temperature are all important parts of the weather. Scientists do not know how to change a sunny day into a rainy one, but it is possible to control each part of the weather in a small way.

Suggested teaching activities

1. *Have adult learners dig into the soil in several different places (for example, in a bare field, under a tree, and in an area covered with grass). In which place is the soil driest? Where is the soil most moist? Can you explain why?*

2. *Have adult learners discuss or write about the following—*
   a. *On a windy day, what places do you know which are protected from the wind?*
   b. *What damage does the wind do in your area? Is there anything you could do to prevent the damage?*
   c. *During a dry period in your area, what places get dry first? Are there any places which always stay moist?*
   d. *How do farmers in your area control the moisture in their fields?*
   e. *Where do you store things to protect them from heat, sunlight and moisture?*
   f. *Do you know of any plants which are easily damaged by too much sunlight? If so, where should they be planted?*
   g. *On a very hot day, where would you go to keep cool?*
   h. *Where do you store food to keep it from spoiling?*

E. SOIL EROSION

Key concept: *Unless it is protected, soil can easily be carried away by wind or water over a period of years, making land worthless.*
Key words: *Erosion, delta, laterite soil. ('Laterite soil' is an important term only for those moist, tropical areas where it occurs.)*

Scientists believe soil has come mostly from solid rock. Over a period of many thousands of years, wind, rain, and other natural forces can break rocks into tiny pieces. On a beach or along a river, you can often find sand. This sand is actually made up of tiny pieces of rock which have been broken up by the water. Almost all soil contains some sand, but in good soils much of the rock has been ground so small, like particles of flour, that single pieces are hardly discernible to the eye. Good soils also contain material from dead plants and animals. Natural forces can sometimes change an area of bare rock into a fertile region with soil and plants and animals—but the process is timeless if measured in one life of man. It may

take thousands or even millions of years to change rock into soil.

One of the most serious problems in the world is that the soil in many places is being carried away. Sometimes the soil is being blown away by the wind. In other places, the soil is washed away by rain or floods, and carried down rivers to the sea. After the soil is carried away, a farm or an entire region becomes almost worthless. Erosion is the word used to mean any process which carries away the soil.

In places where men have not disturbed the land, there is usually little problem with erosion. For example, in a forest the roots of the trees go down and spread into the soil, holding it together, thus preventing its erosion. It often happens that men and women go into a forest region and cut down the trees, either to use the wood or cultivate the land. With the trees gone, there may be nothing left to hold the soil together. It sometimes happens that a few years after the trees are cut, an area becomes a wasteland. The soil may be washed or blown away, and the land becomes cut with deep gullies.

If the trees are cut in a certain area, it is important to find some other form of soil protection. Sometimes the best method is to cut only part of the forest, leaving some trees behind. Sometimes it is helpful to build terraces on the hillsides. There are many different methods for protecting the soil. The important point is that soil left bare is in danger of being carried away by wind or water. Some means must, therefore, be devised to protect it.

In the moist tropics, another process sometimes destroys soil without actually carrying it away. Many tropical areas have a type of soil called 'laterite soil'. Laterite soil can be used for several years to grow crops, but if it is left exposed to rain and sunlight it gradually becomes harder and harder. Eventually this soil becomes rocklike and is worthless for farming. It is important that laterite soil should not be left uncultivated for long periods of time.

Even if the soil is not ploughed, it can sometimes be destroyed by cattle, sheep or other animals. Many parts of the world have few trees, but are covered instead with grass. This natural grass protects the soil and holds it together. If animals eat too much of the grass, the soil can be exposed to the rain and wind and in time is carried away.

Some people actually benefit from soil erosion. When soil is carried away by a stream or river, it often settles in a delta where the river reaches the sea. For example, the Nile Delta in Egypt is made up of fertile soil carried down for thousands of years from other parts of Africa. The Ganges Delta in India and Bangladesh is made up of soil carried from a

large area of southern Asia. People who live on deltas often have some of the finest and most fertile soil in the world, but they still need to protect it. If it is not protected, even the rich soil of a delta may be carried into the ocean and lost forever.

When soil is not protected it can be destroyed by wind, rain, and other forces. The destruction sometimes occurs in a single day, during a flood, a heavy rain or a strong wind storm. More often, the destruction is slow and hard to perceive. A field may produce crops for many years before erosion gradually makes it worthless. Anyone who uses the land for farming, grazing, logging or any other purpose needs to protect the soil, so it will still be there for succeeding generations.

Suggested teaching activities

1. *Take three or four jars and fill each one about quarter full with soil from different spots. In one jar, you might put soil from an old field. In another is soil from an area which has never been farmed. Fill each jar nearly to the top with water, shake it thoroughly, and let it stand for about half an hour. After the soil has settled to the bottom of the jars, have the adult learners examine them and discuss any differences among the various soils. The larger pieces of rock and the sand should be at the very bottom of the jar. On top of the sand, you should see very tiny pieces of rock and soil, so fine it resembles flour. On top of the soil (perhaps even floating in the water) there should be pieces of dead plant and animal material. Where did you get the soil which has the most sand? Where did you get the soil with the most plant and animal material? Which soil is most fertile?*
2. *Take two boxes tilted at similar angles. In one place a piece of turf, and in the other place loose soil. Run a similar amount of water into each box, and collect samples of the water which runs out of each box. Which box suffers more soil erosion?*
3. *Have the adult learners discuss or write about the following—*
   a. *Do you know of any farms or other places in your area where the land has been destroyed by erosion? If so, describe exactly what happened.*
   b. *Do you know of any ways in which the soil in the area where you live has changed since you were a child? Have the changes been good or bad? How do you think the soil might change in the future? Is there anything you can do to control future changes?*

c. *Is any of the soil on your land being carried away by wind or water? Is there anything you can do to prevent erosion?*
d. *What government agencies or other institutions would you contact to learn more about erosion control?*

F. SPACE

Key concepts: *The sun, moon, planets and the stars are gigantic in size and are distant from our earth which is one of the planets.*
Key words: *Astronomy, sun, moon, stars, planets, constellations, telescopes, satellites, meteors, comets.*

For many centuries, men and women have watched the stars and wondered about them. One of the oldest sciences is astronomy. It is the study of the stars and other objects in the sky.

If you watch the sky, you can see several different kinds of object. During the day, the most important of these is the sun. The sun is so bright that it is dangerous for a person to look directly at it. Anyone staring at the sun, can have their eyes burnt. Their sight can even be destroyed. The sun is extremely important because it gives us the light and warmth without which we cannot exist.

In the past, many people believed that the sun was a god. Today, scientists have examined the sun through telescopes and other instruments. They have despatched rockets into space which went near the sun. From their observations and experiments, scientists now know the sun is an object, shaped like a ball, and is 100 times larger than the earth. It is about 150 million kilometres away. The sun burns in a special way, and is much hotter than any fire on earth. Even though the sun is so far away, it still appears large and is so hot that we can feel the heat from it whenever we stand in its rays. Scientists estimate that the sun has been burning for about 5,000 million years, and that it will continue to do so for another 5,000 million years.

The sun is the brightest object in the sky. The second brightest object is the moon. Many people believe the moon only appears at night, but you can often see it in the day. It is harder to notice the moon in daylight,

because the sun is so much brighter.

The sun is intensely hot and shines like a fire, but the moon is cool. We see the moon only because the rays of the sun light it. The moon appears to change shape, but this is because we see different parts of it on different days. The moon looks as if it were about the same size as the sun, but it is actually much smaller. It looks so large, because it is much nearer the earth than the sun. Near is a comparative term, for the moon is, in fact, about 380,000 kilometres away.

If you look carefully at the moon, you can see what appear to be mountains on its surface. For many years, scientists thought these were moon seas, but now we know they were wrong. The moon does have mountains and plains, but it has no water. It also has no air. In 1969, for the first time, two men travelled from the earth to the moon, and walked on its surface. They took photographs and collected moon rocks to bring back to earth. Scientists studied the rocks, and we now know the moon is made of rocks much like the rocks on earth. Still, the moon is arid and dead. Nothing can live for any length of time on the moon. The astronauts, as they are called, were able to stay on the moon for a few days, because they carrried their own food, water and air. The journey to the moon and back took about a week and cost many millions of dollars.

Besides the sun and the moon, there are stars in the sky. People have often thought that some groups of stars formed pictures resembling animals, people or objects. The Plough is a group of stars with which most of us are familiar. These groups of stars are called constellations. Sometimes sailors and navigators use the constellations, like sign posts to guide them in their travels. Most of the stars stay in the same patterns, and people have been watching these constellations for thousands of years.

By looking at stars through telescopes, scientists have discovered that each star is really another sun. The only difference between a star and the sun is that stars are farther away. The sun, as we have stated, is 150 million kilometres from the earth, but the next nearest star is about 37,000,000 million kilometres away. Each star is a gigantic, burning ball, but they are so far away they seem tiny and twinkle pleasantly.

Most stars remain in the same constellations year after year, but a few 'stars' seem to wander about. If you watch one of these 'stars' for a few weeks, you can see that it does not move in the same way as the other stars. These wandering 'stars' are called planets, and are not stars at all. Planets are cool, somewhat like the moon or the earth, and they are essentially large balls of rock. In fact, the earth is one of the planets. The earth is a large ball of rock, with soil, water and air on its surface. Like the other

planets, the earth is moving through space, but as we move with it and gravity holds us to the earth, so we do not notice the motion.

No one has ever travelled to another planet, but scientists have studied them carefully using telescopes. Also, rockets with automatic cameras and radio transmitters have landed on two of the closest planets—Venus and Mars. Since the other planets are somewhat like the earth, people have long wondered if there might be life on them. So far, all other planets seem to be without life. Conditions on Mars and Venus are worse than any desert on earth, and nothing seems to live there. On the other hand, there are millions of stars in the sky, and each star is another sun. Perhaps some of these stars have their own planets, and perhaps there are plants or animals—or even people—living on those distant planets. For now, no one knows.

There are several other kinds of object in the sky. Often people see meteors, or 'falling stars'. These are small spots of light that flash rapidly across the sky. If you watch the sky carefully on a clear night, sometimes you can see a dozen or more meteors within a few hours. Actually, a meteor is a small piece of rock which falls from space into the earth's air, and in passing through the air at great speed becomes so hot it glows.

Another interesting kind of object which sometimes appears in the sky is a comet. Comets are small planets, but they are unusual because they have 'tails'. Sometimes, comets are particularly bright. In 1986, such a bright comet, named 'Halley's Comet', will appear in the sky. This comet returns once every 75 years. Most comets are not as bright as that named after the astronomer Halley who first observed it in 1682, but comets can be seen several times a year by people who watch the sky carefully. Some people hold the belief that a comet is a supernatural omen of a coming disaster, but scientists do not accept this.

Since 1957, there has been a completely new kind of 'star' in the sky. Perhaps you have seen them appear in the evening or early morning and move across the sky and disappear a few minutes later. These new 'stars' are actually man-made satellites. Most satellites are roughly the same size as an automobile. A few of these satellites have carried men inside, but most only contain automatic cameras, radio transmitters, and other technical and sophisticated equipment. Some of these satellites take pictures of the earth to show where there are storms, so people can be warned when a dangerous storm is moving towards them.

Suggested teaching activities

Have adult learners discuss or write about these questions—

1. *Would you like to go to the moon? Why or why not?*
2. *What different kinds of object have you personally seen in the sky? Have you seen a meteor or a comet? Have you seen a satellite? Describe exactly what you saw.*
3. *Do you believe scientists will ever find people living on another planet?*
4. *What constellations can you recognize? Do you know any stories about them?*

CHAPTER IV

Health

Parasites and bacteria—Preventing infections
Drugs and medicines—Human nutrition
Reproduction and family planning—Mental health
Health problems

A. PARASITES AND BACTERIA

Key concept: *Many diseases are caused by living things (called parasites or bacteria) which can live on a person's skin or inside his body.*
Key words: *Parasites, bacteria,* infection.*

What do you believe is the most dangerous kind of animal? In some parts of the world, people must be careful to avoid bears, lions, tigers, wolves, crocodiles, sharks or other large animals. Certainly these animals are dangerous, and they can sometimes kill men, women and children. On the other hand, in most places these large animals are not really a serious danger. Lions, for example, are not very common. Even if a person does see a lion, he can usually escape by going in the opposite direction.

In many parts of the world, poisonous snakes are far more dangerous than the larger animals. A snake can be more dangerous than a lion or a bear for several reasons. A lion or a bear endeavours to stay away from people, but poisonous snakes sometimes come into a farm, a village or even a house. Also, it is easy to see the large animals, but snakes are sometimes difficult to see. A person might accidentally step on a snake without

* The word 'bacteria' is used here to mean all living things which are too small to be seen without a microscope. This includes viruses, fungi, and other small, disease-producing organisms, which are not (strictly speaking) bacteria.

noticing it. Most snakes are harmless, and many are beneficial because they eat mice and other pests. Still, some snakes are very dangerous because they can inject a deadly poison when they bite.

While snake bites can be dangerous, doctors can usually help save the life of a person bitten. They can inject a drug which acts against the poison. There is a different drug for each kind of snake bite, so the doctor needs to know exactly what kind of snake it was. Also the drug must usually be given soon after the bite, or it may be too late. Unfortunately, for some kinds of snake, scientists have not yet been able to make a drug which will help the victim. In addition to drugs for treating snake bites, there are several methods for removing the poison from a person's body or for preventing it from spreading to his heart and other vital organs. Often local people have learned to use these methods when a doctor is not available.

Poisonous snakes are very dangerous, but they are not the most dangerous living things. Sometimes a person will become sick—and perhaps even die—for no apparent reason. For many years, scientists tried to understand what caused these sicknesses. After a long time, they discovered that many such illnesses are caused by very small—but dangerous—living things, called parasites or bacteria. Snakes kill thousands of people around the world every year, but parasites and bacteria yearly kill *millions* of people.

Some parasites live on the outside of a person's body. They also live on the skin of animals. Fleas and lice are two kinds of parasites which may live in a person's hair. These parasites can make a person uncomfortable, but they are not usually dangerous. A person can often get rid of fleas and lice by keeping himself and his home clean. There are also special powders which will kill these parasites.

The more dangerous parasites can live on the *inside* of a person's body. Parasites also live inside the bodies of animals. You may have seen worms in the meat of a dead animal. The worms are a kind of parasite which had been living inside the animal while it was still alive. The parasites in the meat of an animal can stay alive even after the animal is dead, and if people eat meat without cooking it carefully the parasites may get into their bodies. When the parasites are living inside a person's body, they can weaken an individual and sometimes cause death. Most parasites are small, although some worm-parasites can be quite long. Many parasites are so small that it is impossible to see them without a microscope. (A microscope is like a powerful magnifying glass, and makes small things look large.) A doctor can give a person drugs to kill the parasites, but the treatment can be slow and difficult. Parasites are sometimes difficult to kill after they get

inside a person's body. Often the parasites get inside after a person eats unclean food or drinks impure water. Other parasites enter through the skin, especially the soles of the feet if a person walks barefoot. When parasites enter a person's body, they are so small he probably will not notice them, but they can grow and reproduce inside an individual and make him acutely sick.

Parasites are dangerous; they kill far more people than do snakes. The most dangerous of all, however, are a special kind of parasite called 'bacteria', sometimes identified as 'germs' or 'viruses' or 'microbes'. Unlike worm-parasites, bacteria never grow very large. In fact, they are very, very small. One of them is much smaller than a grain of sand and it is impossible to see them without a powerful microscope.

How could such a small thing be so dangerous? The reason is that bacteria are innumerable and hard to see. Scientists looking for bacteria using microscopes and other methods have revealed that we are surrounded by bacteria. There are bacteria on plants, in the air, and even on our skin. The largest numbers of bacteria can be found in three places—in the soil, in manure from people or animals, and in any food which has begun to spoil.

Most bacteria are not dangerous, just as all snakes are not poisonous. Bacteria actually perform useful functions. Scientists have discovered that it is living bacteria which cause bread to rise. Those same bacteria (called yeast) make the alcohol in beer and wine. Yeast is made of living things too small to be seen, but yeast does not harm a person even if he eats or drinks something which contains it. Other useful bacteria are used to make yogurt, cheese and several other kinds of food.

Most bacteria are harmless, but some can cause diseases. Some of the diseases are minor, such as colds or pimples. A few kinds of bacteria cause serious diseases, and these are the most dangerous living things in the world. These bacteria are like poisonous snakes, because they can inject poison into a person's body. They are worse than snakes because they can live inside a person's body. A snake bites a person once then goes away; but bacteria can keep releasing poison for as long as they stay alive inside the body.

If there are so many deadly bacteria around, it may seem amazing that people ever stay healthy. Fortunately, the human body is well defended against bacteria. The best defence a person has is his skin. Normally, bacteria live on the surface of the skin, and if they do not get underneath the skin they cannot harm anyone. If some bacteria do get under the skin, the human body is still able to fight back. There are substances in our

blood which work to kill bacteria that get inside. As long as a person is strong (and has enough food, rest and exercise), his body can normally kill the bacteria which get inside.

A dangerous situation occurs when one of three things happens: (1) a person's body becomes weaker, because he does not have enough food or rest, or for some other reason; (2) a large number of bacteria get into the body; or (3) a few, very strong bacteria get into the body. If any of these things happens, the bacteria may be stronger than the person's body, and they may be able to live inside it. Bacteria can reproduce rapidly. In just a few days or weeks, a small number of bacteria may reproduce into many millions. These bacteria release their poison which can make people acutely ill. The invasion of the body by bacteria is medically termed an 'infection'.

Some infections, such as colds, are not normally serious. After a few days, the strength of the body destroys the bacteria. A person may be uncomfortable for several days, but the condition is not dangerous. Other kinds of infection can be more serious; for example, infections which cause smallpox, cholera, leprosy, typhoid fever or malaria. Each disease is caused by a different type of bacteria. Some bacteria are so strong, that the body cannot kill them without help. Often doctors can use drugs to help kill the bacteria. Unfortunately, a drug which works to kill one kind of bacteria may not work against another kind. In any serious illness, a doctor needs to examine the patient to see what kind of drug to use. It can be dangerous to give a person who is seriously ill a drug from the chemist's shop or from herbs, unless a doctor has recommended it. For most common infections, the body can cure itself in a few days. If a disease seems serious or if it lasts for several days, a doctor should be consulted.

Bacteria cause many diseases in people, and can also cause diseases in animals. Sometimes animals get similar diseases to a person, or sometimes they have diseases which never affect people. Infections in animals are caused by bacteria living inside their bodies, and they can be treated by veterinarians in much the same way doctors treat people. Even plants sometimes become 'sick' because they have bacteria living inside them.

Suggested teaching activities

1. *Have adult learners discuss whether or not they believe the idea that many sicknesses are caused by bacteria and parasites living inside a person's body.*
2. *Have them discuss what illnesses are most frightening to them. Use an*

encyclopedia or a book about health, and try to determine if each of the illnesses they mention is caused by parasites, bacteria or something else. Also discuss how each illness might be treated or prevented.

B. PREVENTING INFECTIONS

Key concepts: *To prevent infections, a person should keep himself strong, and keep bacteria out of his body. Vaccinations can also help prevent some specific diseases.*
Key words: *Vaccination, epidemic.*

There are two simple rules for preventing infections: (1) keep the body as strong as possible, and (2) keep bacteria out of the body.

Often, infections strike children and old people—because their bodies may not be as strong as those of young adults. Pregnant women also need to be especially careful to prevent infections, because their bodies may be weakened by the strain of carrying a baby. Everyone should try to stay as strong as possible, by being sure to have enough good food, enough water, enough rest and enough exercise. If people are strong, their bodies can protect them from most infections.

Another way in which a person's body can be made strong enough to fight infections is through vaccination. A vaccination is the injection of a substance to prevent a disease. After a person has the disease, a vaccination cannot help him. Other substances may, however, be injected to help ill people. One of the most important discoveries scientists and doctors have ever made was a vaccination against smallpox. A few decades ago, smallpox killed many thousands of people every year. Recently, there has been a world-wide campaign to vaccinate everyone against smallpox, and now the disease has been almost totally eliminated.

Unfortunately, a vaccination protects a person against only one disease. For example, the smallpox vaccination does not keep a person from getting cholera or some other disease. Also, the protection does not last forever. After a certain number of years (which depends on the particular disease), the vaccination needs to be repeated. Scientists have developed vaccinations for smallpox, polio, tetanus, diphtheria, tuberculosis, cholera, and

several other diseases. Some of these (for example, smallpox) are very effective, so it is almost impossible for a person who has been successfully vaccinated to get the disease. Other vaccinations (such as that for cholera) can only help prevent the disease, but a person who has been vaccinated still needs to take care. There are many diseases for which scientists have not yet discovered an effective vaccine, but research still continues.

Vaccinations can help make the body strong enough to fight against certain kinds of bacteria, but the most important way of preventing infections is by keeping bacteria out of the body. To do this, it is important to know some of the ways bacteria can enter the body.

Many bacteria get into the body through the mouth, with food and water. To prevent infection, people need to be sure the water they drink does not contain too many bacteria. The most dangerous water comes from ponds, streams, or rivers which contain some human manure or faeces, because human faeces often contain dangerous bacteria. Sometimes a stream goes past one village, and human waste from that community of people runs into it. If people in another village drink water from that stream, then bacteria can get into their bodies. Even when water looks clear and clean, it may contain millions of bacteria. The human body is a strong fighter against bacteria, and people may drink water like this for many years without becoming sick. On the other hand, the bacteria can still be killers. Children and old people may become sick because of the bacteria, even if young adults do not. There are several ways of treating drinking water to kill any bacteria in it. The safest way is to boil the water for at least 20 minutes. The boiling kills the bacteria. To prevent illness from infection, a well-made latrine or toilet is also important. Water deep in the ground is usually safe, so a deep well is a good source of water. On the other hand, if a well is too shallow or if it is near a latrine, the water from the well may be dangerous.

Sometimes many people become sick at the same time with the same disease. This is called an epidemic. Many epidemics are caused by bacteria in drinking water. If many people in an area become sick at one time, it is suggested that everyone begin boiling all water before using it.

Food can also carry bacteria into the body, especially if the food is dirty. Dirt often contains many dangerous bacteria. To be safe, food should be washed carefully, or it should be cooked. Meat, especially, often contains bacteria or parasites, and it should always be cooked thoroughly. The heat of cooking kills the bacteria and parasites. Any food which has begun to spoil is extremely dangerous and should not be eaten.

Besides the mouth, bacteria can enter the body through any break in the

skin, such as cuts or scratches. There are always bacteria on the outside of the skin, and even a small cut lets some of them get inside. To be safe, a person should wash any breaks in the skin, and keep them away from dirt, manure, and other sources of bacteria. Sometimes people also put iodine, alcohol, or other medications on cuts to help kill the bacteria.

Often, insects carry bacteria. When an insect bites through the skin, the bacteria may be able to get inside the body. The bacteria which cause malaria are carried in this way by mosquitoes. Flies and other insects may also carry bacteria. When flies alight on food, some of the bacteria they carry may stick to the food, and a person who later eats the food might become sick. To be safe, you should try to keep insects out of your house, and especially try to keep them away from food.

Some bacteria also enter the body through the nose, with the air we breathe. Of course, we have to breathe, so it is difficult to prevent bacteria from entering in this way. If possible avoid being near people who are sick, so you do not breathe in bacteria from them. The bacteria which cause colds enter with the air, and so do the bacteria causing tuberculosis.

Another way bacteria can enter the body is through the sex organs during sexual intercourse. Several diseases (particularly syphilis and gonorrhea) are caused by bacteria which can enter the body in only this way. A person can get one of these diseases by having sexual intercourse with someone who already has it. Unfortunately, a person (particularly a woman) may have the disease for several years and not show any outward signs. Even people who look and feel healthy may have these bacteria living in their sex organs. Condoms can help prevent such infections. The bacteria which cause syphilis and gonorrhea are strong, and the human body can rarely kill them unassisted. Doctors can provide drugs which will kill these bacteria. Such diseases are slow to develop but extremely dangerous. If they are not treated by a doctor, they may seem to go away for a while, but the bacteria are still there, and the disease will return. Unless treated properly, these diseases can cause sterility, blindness, insanity, deafness, paralysis and even death. A child born to a mother with one of these diseases may also have the infection, and be affected in the same way.

Suggested teaching activities

Discuss with learners—

1. *The history of smallpox in their region. Some of them may remember people who had the disease and perhaps died of it. Most of them should*

have been vaccinated for smallpox and they should still have the scars from the vaccination.

2. *What other diseases have they (or their children) been vaccinated against?*
3. *Where do they get their drinking water? Is it possible that some human faeces get into it?*
4. *What are they doing now to prevent infections? Discuss what other things they might do.*

C. DRUGS AND MEDICINES

Key concepts: *There are many different kinds of drug. They need to be used with care. Most drugs can also be poisons if used improperly.*
Key words: *Drugs, medicines, antibiotics, vitamins, minerals, laxatives.*

One of the most important things scientists have achieved after many centuries of work is the discovery of a large number of drugs to help people keep well. Drugs or medicines (the two words mean nearly the same thing) are usually obtained from hospitals, doctors or chemists, but some of them can also be found in natural plants. Sometimes, local people have learned to collect certain leaves, berries, or roots which contain useful drugs. Often drugs are taken through the mouth, in the form of pills or liquids. Sometimes drugs are given through the skin with an injection needle. Other times they are inhaled into the lungs. Some drugs are just rubbed into the skin in the form of an ointment, or placed inside the anus or vagina.

It is important to realize that most drugs are much like poisons. In small amounts, given at the right time, drugs can be useful and can save lives. But almost any drug can be a poison if a person takes too much or takes it in the wrong way. Some drugs are actually made from snake poison or from poisonous plants. All drugs need to be used carefully, and on the advice of a doctor.

Another important point is that no single drug is good for everything or for everyone. Sometimes a person who is sick takes a drug which a doctor prescribed for someone else. This is dangerous. If the two people have different diseases, a drug as given to one person may be useless or even harmful to a second person. Even if they have the same disease, the same

drug may be bad for people of different ages, sexes, or general health. For example, a drug which helps an adult might be poisonous to a child.

One important group of drugs are called 'antibiotics'. These drugs help kill bacteria living inside a person. Scientists and doctors have searched for many years, trying to find drugs which are strong enough to kill bacteria, but which do not harm a person. Such drugs save many thousands of lives every year, but they must be used with great care. A patient who takes antibiotics should follow instructions carefully. Often, such instructions may be to take a certain number of pills each day for a prescribed number of days. For example, two pills a day for 20 days might be recommended. A person taking more than the recommended dosage could become more ill or even die. If fewer pills than instructed are taken, the drug may not be strong enough to kill the bacteria. Sometimes after a few days, a person will feel better and stop taking the drug. This can be dangerous because there may still be a few bacteria alive inside his body. If he stops taking the drug too soon, these bacteria may again multiply and illness will recur. Another problem with antibiotics is that the same one will not work for all diseases. A doctor must decide when a person needs an antibiotic, which antibiotic is necessary and what quantities to take.

Vitamins and minerals are other kinds of drug. Often people buy these drugs from a chemist when they feel weak. Vitamins and minerals are needed to stay healthy, but there are vitamins and minerals in food, and most people get enough from what they eat. Instead of buying vitamins and minerals, it is usually better to eat a variety of foods—including green vegetables, fruits, meat, fish or poultry.

Pain relievers, such as aspirin, are a third kind of drug. Often people take these drugs to stop a headache, a toothache, a stomach ache, or some other pain. These drugs make a person *feel* better, but they do nothing to cure his disease. Pain is a warning signal that something is wrong. For example, a toothache is a signal that something may be wrong with a tooth. If the pain soon goes away, probably there was nothing seriously wrong. If the pain continues for several days, something needs to be done to cure the problem. It is generally all right to use pain relievers for a short while to make oneself *feel* better, but they should not be used for long. Even a toothache can become very serious, if it is treated only with pain killers.

Laxatives are a fourth kind of drug. People can take laxatives occasionally, when they need them, but they should not be taken in excess.

There are many other kinds of drug, but only one other sort will be mentioned here—the drugs used for pleasure. One of the most common drugs used for pleasure is alcohol, in the form of beer, wines or spirits.

Alcohol is a drug, because (like other drugs) it produces changes in a person's body. It can be a pain reliever, and it can make a person feel more relaxed. Alcohol can also make it difficult for a person to see well, and it can make it hard for him to walk steadily. If a person drinks enough alcohol, he will become unconscious. Drinking large amounts of alcohol quickly can be deadly. If a person drinks excessive alcohol for many years, it can cause permanent body damage particularly to the liver. Like all drugs, alcohol may be safe when used in small quantities at the right time, but it can be dangerous if used immoderately.

Another common drug in universal use for pleasure is tobacco. Most people do not think of tobacco as a drug, but it is a drug because it contains substances which produce changes in the body. In some ways, tobacco is just the opposite of alcohol. Alcohol makes a person relax, but tobacco makes him more excited and makes his heart beat faster. Like all drugs, tobacco can be dangerous if it is taken in excess. If a person smokes tobacco for several years, it can cause several diseases of the lungs and heart.

Several other drugs are also used for pleasure by some people, including opium, heroin and marijuana. These drugs are generally considered so dangerous that they are illegal in almost every country. Scientists disagree among themselves about how dangerous marijuana really is, and its use seems to be coming more common in a number of countries.

Suggested teaching activities

1. *Get several containers of medicine from a doctor, a chemist or even from the learners. Discuss what kind of drug each one is, what it is used for, and exactly how it should be taken.*
2. *Discuss what drugs learners use and why they use them.*

D. HUMAN NUTRITION

Key concepts: *To be healthy, every person needs to eat a variety of good foods. It is especially important for children and pregnant women to eat enough of the right foods.*
Key words: *Malnutrition, sugar, starch, protein, fat, vitamins, minerals.*

To stay alive and healthy, every one needs food and water. If people do not have enough food and water, they will weaken, and eventually may starve to death. Fortunately, few people actually die of starvation in the world today, although earthquakes, floods, wars or other disasters sometimes bring about conditions under which people starve. A more common problem is malnutrition. People eating enough food, but not the right kind of food, are said to suffer from malnutrition.

Malnutrition can make people weak or sick. It can be extremely serious for growing children because their bodies and minds may be permanently damaged if they are not fed correctly. One of the most important periods is while a child is still inside the mother's womb. If mothers do not eat the right food, in sufficient quantities, their children can be crippled or mentally retarded.

Many people eat only one kind of food. For example, a man might eat nothing but rice for a long time. For a few weeks, this man might remain healthy, but he would gradually become weak and sick. No matter how much rice he eats, he will still become sick because he needs to eat other kinds of food.

Other people might eat nothing but meat. They would also become sick after a time, unless they varied their diet.

A third person might eat nothing but green vegetables. Again, illness would follow after a while.

People need to have enough food to eat, but they also need that food to be varied. Scientists have conducted many different experiments to learn exactly what kinds of food people need to remain healthy. A balanced diet must contain (1) starch or sugar, (2) protein, (3) fat, and (4) vitamins and minerals. People need all these things to be healthy. If one or other is missing from the food people eat, they are likely to become ill.

Starch and sugar provide people with energy. This is the most important kind of food a person needs, and they should eat 'energy' foods regularly. People doing hard physical work should eat more energy foods. A student or someone else who does not do much hard, physical work does not require to eat as much. Sugar is found in fruits, sweets, soft drinks and anything else which tastes sweet. Starch is found in bread, noodles, rice, millet, maize, and other foods made from grain. Starch is also found in potatoes, yams, cassava, beans, peas and several other foods. The human body can change starch into sugar, so it is not necessary to eat both starch and sugar, but only one or the other. If you chew a piece of bread in your mouth for several minutes, you can taste it becoming sweet, because the juices in your mouth are changing the starch into sugar.

Protein is also necessary for good health. No matter how much starch or sugar people eat, they are liable to become ill unless they have an adequate protein intake. Protein is found in meat, fish, poultry, eggs and milk. There is also some protein (although less) in nuts, beans, peas and some other plant foods. Foods containing proteins are often expensive, so people are inclined to eat a large amount of starch and little protein. Protein shortage is one of the world's most serious health problems. Growing children need protein even more than adults. Milk from the mother's breast is a good source of protein, but parents need to ensure that their children eat protein foods after being weaned. It is not necessary to eat large amounts of protein foods, but everyone needs to eat a certain quantity every week.

The third type of food everyone needs contains fat or oil. Fats are found in meat, poultry, milk, nuts, cooking oil, and several other foods. The body does not need a great deal of fat, and the little it needs can be obtained from many different foods. Shortage of fat in the diet is not nearly so serious a problem as shortage of protein.

The fourth type of food is vitamins and minerals. There are many different vitamins and minerals necessary for good health. One important mineral is salt. Everyone needs to take salt, and people can get it either by buying it directly and adding to food, or by eating foods (especially meat and fish) which contain natural salt. There are many other necessary minerals, including iron, calcium and iodine. Calcium is especially important to children, because it is necessary for their growing bones. If a child does not have enough calcium, his bones may be weak. The best source of calcium is milk, either from the mother's breast, or from cows or goats. Iron is necessary for the blood, and is found in meats (especially liver) and in several fruits and vegetables. The iron we need in our food is the same as the iron used to make nails, automobiles and other things, but we need only a small amount and we need to get it in special forms—so swallowing a nail will not do! Our bodies need only a tiny amount of iodine, but people sometimes do not get enough, and this can cause a disease called goitre, in which the neck swells. There are many other minerals we need in small amounts.

Vitamins are another group of substances similar to minerals. They have letters for names (for example, vitamin A, B, C, etc.). Vitamins are usually found in fruits and green vegetables. The body needs only a small amount of each vitamin or mineral, but it is necessary to have all of them. If any one vitamin is missing from the food people eat, they can become ill. Sometimes people buy vitamins and minerals from a chemist, but this is

usually not necessary. A person can normally get all the vitamins and minerals needed by eating a variety of good foods.

To be sure of having a good nutritious diet people should eat *some* foods from *each* of these four groups *every* week:

Starchy foods, such as rice, bread, noodles, millet, maize, potatoes, yams, cassava and beans.
Protein foods, such as meat, fish, poultry, eggs and milk. (Beans, peas and nuts can also provide some protein.)
Green vegetables, such as spinach, okra, peppers and many others. (Generally, the more brightly coloured a vegetable is, the more vitamins and minerals it contains.)
Fruits, such as oranges, tomatoes, grapefruit, papaya and many others.

Suggested teaching activities

1. *Get adult learners to make a list of the foods their families will probably eat during the next week. Discuss whether or not the foods listed are likely to provide everything a person needs to be healthy.*
2. *Have students list all the foods a young child might eat during the first few months after it is weaned. Discuss whether or not these foods are likely to provide everything the child needs.*

E. REPRODUCTION AND FAMILY PLANNING

Key concepts: *The life of a new baby begins following sexual intercourse when sperm from the man unites with the woman's egg inside her body. If a couple wish to avoid pregnancy, there are several methods they can use to keep the sperm and egg apart. If a couple wish to have a child, but the woman does not become pregnant, doctors may be able to help solve this problem.*
Key words: *Conception, sperm, egg, puberty, menstruation, menopause.*

The birth of a child is an important event in the lives of men and women. Usually, births of children call for happy celebrations. In some cases, particularly if a couple already have several children, another child may be a hardship for the family. Too many pregnancies, coming only a year or two apart, can also be dangerous to a woman's health.

For thousands of years, doctors and scientists have studied childbirth. Today, doctors know how to help couples control the number of children in the family. Some couples are anxious to have a child but the wife may live for several years without bearing one. Often, doctors can help a couple such as this towards a healthy childbirth. On the other hand, there are couples who decide that they do not want to have more children. Many couples also decide that they want to wait for a few years before having a child. Doctors can help such couples to avoid or control the rate of birth.

The life of a new baby begins after sexual intercourse when sperm from the man unites with an egg inside the woman's body. This process is called conception. The egg is small (smaller than the full-stop at the end of this sentence), but it begins to grow rapidly inside a woman's womb. After three months inside the womb, the new baby has grown to about the size of a finger on an adult's hand. The baby continues to grow inside its mother until it is born, about 9 months after conception. While inside the womb, the baby gets the food, water and air it needs from the blood of its mother.

It is impossible to control whether a child will be a boy or a girl. Women produce only one kind of egg, but men produce two kinds of sperm—one kind of sperm makes boys and the other kind makes girls. Every man has both kinds of sperm, and it is a matter of chance which one unites with the egg.

Young girls do not produce eggs, and young boys do not have sperm. Boys and girls become physically able to have children soon after puberty. Puberty normally occurs some time between the ages of about 11 and 17. For a boy, puberty normally includes the growth of hair on his face and body, and a change in his voice. The most important change in a boy's body (although it cannot be seen) is that his sex organs begin to produce sperm. For a girl, puberty includes the growth of her breasts and the beginning of menstruation. Menstruation is a sign that a girl's body is beginning to produce eggs.

A woman normally produces one egg at a time, roughly once a month. Sometimes a woman may produce two or more eggs at the same time, and this can result in the birth of twins or triplets. Between one and three weeks after the start of the last menstrual period, the new egg is ready. If a woman has sexual intercourse during this time, the man's sperm may unite with her

egg and she may become pregnant. If, for any reason, sperm does not reach the egg, then the egg (together with some blood and matter from inside the womb) will pass out of the woman's body. This is the menstrual bleeding. After it is over, a new egg is produced and the process begins again.

A woman normally continues to produce eggs and have menstrual bleeding until some time between the ages of 40 and 60. At that time (which is called menopause) her body stops producing eggs and she stops having menstrual bleeding. After menopause, it is no longer possible for a woman to become pregnant.

If a couple do not want to have children, or if they want to wait before having a child, there are several things they can do. Most of these methods work by keeping the egg and sperm apart.

One way to prevent conception is simply not to have sexual intercourse. If there is no sperm inside the woman's body, she cannot become pregnant. Some couples continue to have intercourse—except during the time between one and three weeks after the women's menstrual bleeding when she may produce an egg. If a couple are careful, this method can prevent conception, but it is always difficult to know exactly when the woman actually produces an egg.

Sometimes couples use various devices to prevent conception. A condom is one device which covers the man's penis and catches the sperm. There are also devices which can be placed inside a woman's vagina to catch the sperm before it reaches the egg. It is also possible to buy special creams or foams which can be placed inside the vagina to kill the sperm. If a couple use one of these three methods, they must apply it before each act of sexual intercourse.

Another method of preventing conception is the use of certain drugs. A woman can take drugs which keep her from producing eggs. The exact instructions depend on the specific drug, but usually the woman takes one pill every day during a certain part of her monthly cycle. These drugs must be used carefully, and a woman should not take them without first consulting a doctor.

To prevent conception, doctors sometimes insert a special device into the woman's womb. This method has some important advantages, since the couple do not have to follow any special procedures after the device is inserted. Also, when the couple decide to have children, the doctor can simply remove the device.

With the methods mentioned above, a couple can always decide later to have another child. There are also operations which make a man or woman

permanently unable to have children. If a couple already have children, and they are certain they do not want more children, then an operation may be a good idea. The operation can be done on either the man or the woman, but it is easier on a man. After the operation, the couple can continue to have sexual intercourse and the feelings of pleasure are the same as before. If the operation is done on the man, he will continue to eject fluid during intercourse, but there is no sperm in the fluid and the woman cannot become pregnant.

All these methods mentioned prevent pregnancy. If a woman becomes pregnant, doctors can also prescribe various methods to end the pregnancy. This is more difficult, and it can be dangerous to the woman, particularly if it is done too long after conception. In some countries, it is common for doctors to end a pregnancy when the woman wants this done. In other countries, abortion, as it is known, is extremely controversial or illegal.

Suggested teaching activities

Discuss with learners—

1. *How many children they believe a couple should have.*
2. *Where they could get more information about family planning. If possible, distribute printed matter about family planning for them to read.*

F. MENTAL ILLNESS

Key concepts: *Mental illness is a medical disease of the brain which can be treated by doctors. Some forms of mental illness are caused by infections or injuries. Other forms can be caused by fear or guilt.*
Key words: *Mental illness, insanity, mental retardation.*

One of the major health problems throughout the world is mental illness. There are many people who cannot think properly, even though they may be physically healthy. Sometimes these people are called 'insane', 'crazy' or 'mad'. (Terms used to describe mental illness vary greatly in different areas. It is important to mention whatever words are likely to be familiar to local

readers.) There may be as many people in the world with mental illness as there are with physical sickness, but mental illness is more difficult to recognize as it is not necessarily accompanied by signs of physical illness.

Everyone knows some people who do unusual things. Most of these people are not sick in any way—they just like to do things which normal people do not do. For example, most people sleep during the night, but a few people prefer to work at night and sleep during the day. A person who likes to work all night may be unusual, but he is probably not sick. He may find a job to do at night (perhaps as a night watchman), but otherwise his life is normal and he gets along with other people.

On the other hand, some do not conform. They are, for some reason or other, misfits. For example, a man may imagine that someone or something is trying to kill him, even though those around him know this is not true. His fear may be so strong that he is unable to work, to look after himself, or his family. In extreme cases, a man like this might lock himself into a room and refuse to come out. A person has a mental illness whenever there is something wrong with the way he thinks, which makes him unable to get along without help. A few people suffering from mental illness may do things which are dangerous to others. For example, a man might attack a stranger he meets, because he imagines the stranger is trying to kill him. Fortunately cases such as this are rare, and most people with mental illness are not dangerous to others.

There are people who have believed that mental illness is caused by demons. In the United States and Europe, for example, people with mental illness were sometimes classed as 'witches' and tortured or killed. Mentally ill people have sometimes been chained or locked into small cells. Today it is more readily recognized that people who are mentally ill need special help, not punishment. A special hospital for mentally ill patients was built in Baghdad more than 1,000 years ago. Now doctors and scientists all over the world know that mental illness is just another kind of sickness, and there are many hospitals where such patients can be treated. A person with a disease in his legs may not be able to walk properly; a person with a disease in his mind may not be able to think properly. Mental illness is sometimes difficult to cure, but doctors can help by using drugs and other forms of treatment. The family and friends of a person with mental illness can also help by talking with sufferers in a friendly way and by trying to understand their problems. Unfortunately, many people still believe that mental illness is 'evil' in some way, and they still punish or avoid these people instead of giving them help. If they are helped by others, people with mental illness can often become completely normal again.

Mental illness is a disease of the brain. It can be caused by all the things which cause other kinds of sickness. Sometimes mental illness is caused by an injury, for example by being hit on the head. Sometimes mental illness is caused by bacteria, which may get inside the head and damage part of the brain. Some poisons also can damage the brain and cause mental illness. In some cases, a mental illness can begin in a child even before it is born, because of an infection or an injury inside the mother's womb.

Mental illness can be caused by all the things which cause physical illnesses, but it can also be caused by other things. Two of the things which can sometimes cause mental illness are fear and guilt.

It may seem strange that fear can make a person sick. Everyone is afraid sometimes and fear is normal. For example, it is perfectly normal for a man or woman to be afraid of poisonous snakes. It is also normal for a child to be afraid of the dark. Fear usually does not cause mental illness unless a person experiences it over a long time. For example, a man might be worried for many months that something bad is going to happen to him, such as losing his job or being deserted by his wife. Even if the bad thing never happens, this worrying may make the man physically sick, perhaps with stomach pains. Sometimes this worrying can also make him mentally ill.

Fear can also cause mental illness in children. Children worry about many things. Things which seem unimportant to adults can sometimes be important to a child. When they are afraid, children need to be reassured that their parents love them and will protect them.

Everyone has done some things which make him or her feel guilty. If this feeling of guilt becomes too strong, it can sometimes cause a mental illness. A man, woman or child may begin to hate himself or herself. In some cases, a person may feel so guilty that he will try to kill himself. Often, the thing he feels so guilty about will not really seem at all important to others. Sometimes a person may try to kill himself because of feelings of guilt about a petty theft or sexual experience, although the 'crime' may have occurred many years before.

Another important health problem related to mental illness is mental retardation. Mentally retarded people are sometimes called 'morons', 'imbeciles' or 'idiots'. A mentally retarded person may be normal in most ways, but his mind fails to develop the way it should. Physically, a person like this could be an adult, but his mind may be more like the mind of a child.

Many normal people are sometimes slow to learn things. A person is not mentally retarded, unless he or she is never able to learn the things

necessary to live a normal, adult life.

Like mental illness, mental retardation can have many different causes. Sometimes it is caused by infection or injury. In some cases, it is caused by not eating the right foods. For example, if a child has little or no protein (from meat, fish, poultry, milk, eggs, and other foods), this can cause him to become retarded. Even before birth, a child may become mentally retarded if the mother does not eat a variety of good foods. Unfortunately, most people who are seriously retarded can never be cured entirely. However, many of these can be taught to take care of themselves and to do different kinds of work. It is important to remember that retarded people still need love and concern from those around them.

Suggested teaching activities

Discuss with learners the following questions—

1. *Have you ever known someone with mental illness? How did other people treat this person? How do you believe a person with mental illness should be treated?*
2. *What would you do if someone in your family seemed to be very worried about something?*
3. *If you (or someone you know) seemed to have a mental illness, where could you go for help?*

G. HEALTH PROBLEMS

Key concept: *There are various kinds of illness, with different causes and different methods of treatment.*
Key words: *Parasites, infections, nutrition, poison, mental illness, dentist, teeth, eyes, ears, birth defects, cancer, heart disease, stroke, joints.*

There are many different causes of human illness, as we have read. This section provides a brief summary of some of the things which can go wrong with a person's health. Several of these problems are discussed more fully in other sections.

Parasites (See Chapter IV, Sections A and B)
Parasites are animals which live on a person's skin (for example, fleas or lice) or inside his body (for example, tapeworms, hookworms or trichina worms). Sometimes parasites get into a person's body when he eats food (especially meat) which has not been cooked completely. Some parasites may enter the body in unclean water. Others may enter through the skin, especially the soles of the feet. Parasites can gradually make a person weaker, unless he is treated by a doctor.

Infections (See Chapter IV, Sections A and B)
Infections are caused by the growth of bacteria inside a person's body. Bacteria cause many different diseases, including cholera, smallpox, polio and the common cold. Bacteria can enter the body through cuts in the skin, through the nose or the sex organs, or is contained in water or food. In most cases, the body can kill the bacteria after a few days. If an illness lasts more than a few days, a doctor may have to use drugs to kill the bacteria.

Nutritional diseases (See Chapter IV, Section D)
If people do not eat enough food, they may slowly become weak and sick. Even if people eat a large quantity of food, they may still become sick because they do not have variety in their diets. It is especially important for children to eat some protein, from meat, fish, poultry, eggs, milk, beans or nuts. There are many different diseases which can result because people do not eat a sufficient variety of foods.

Poisons
If a poison gets inside people's bodies, it can make them sick or even cause death. There are snakes and a few other animals which can bite people and inject poison into their bodies. Sometimes people (especially children) accidentally put some form of poison into their mouths. Farmers who work with fertilizers, pesticides, and other chemicals should take care not to get them into their mouths or eyes. Some poisons can also injure the skin. If people get poison on their skin or in their eyes, they should wash it out with water. Anyone swallowing poison or being bitten by a poisonous snake, needs to be taken to a doctor immediately.

Injury
Many people are hurt in accidents. An accident can be serious if the person loses a large amount of blood. When an injured person is bleeding from an accident, another person may be able to stop the flow of blood by covering

the wound tightly with something. An injury is serious when bones are broken. If bones are broken, they may get out of line. If the bones are not put back into line or, 'set' by a doctor, the person may be permanently crippled. Even a small wound may sometimes be infected by bacteria, so if any wound becomes red, swollen or filled with pus, a doctor should be called. To help prevent infections, all wounds should be kept as clean as possible.

Mental illness (See also Chapter IV, Section F)
A person's mind can be sick, in much the same way as his body can be sick. Mental illness can be caused by many different things, including injuries, infections and fear. Most people with mental illness can recover if they are helped by doctors and by their families and friends.

Teeth
There are many different problems which people have with their teeth. One common problem, called decay, is a small hole in a tooth. Dentists can sometimes fill in a hole in the tooth with metal, but if the hole is too deep the dentist may have to pull out the tooth. If a tooth becomes painful, there is probably a deep hole in it that has become infected. If such a tooth is not treated, it can make the person ill. The best way to prevent problems with teeth is to eat good food, brush the teeth regularly and keep the mouth clean.

Eyes
Many people suffer from eye trouble. Some diseases in the eyes can be serious and cause blindness. More often, a person simply has difficulty about seeing things. Some people see things which are far away but cannot see things clearly when they are close. For example, a person might have to hold a book at arm's length in order to read it. Other people can see things close to them, but have trouble seeing things in the distance. Both can usually be helped or corrected by wearing glasses. A pair of glasses which helps one person may not be of use to someone else. So each person needs to visit a doctor or an eye specialist to get the right glasses. In many older people, vision may become cloudy because of the condition called a cataract. Operations can be performed for the treatment of cataracts.

Ears
Many people, particularly older people, have difficulty in hearing. There are a number of reasons for this, including infections and injuries. It can be

dangerous for a person to poke any hard object into his ear as this may cause permanent injury to the ear drum. When a person has ear trouble, doctors are usually able to help.

Birth defects

One of the most frightening health problems is the birth of a child who is in some way malformed. For example, children are sometimes born with six fingers, without feet, or with a misshapen head. Sometimes doctors can correct these problems (for example, by removing the extra finger). In other cases, doctors cannot do much to help. Scientists are trying to understand what causes these defects, and they are seeking ways of preventing them. Many children born with serious defects have grown into successful adults, because their families loved them and helped them.

Cancer

Cancer occurs when a part of the body begins to grow in a strange way. Sometimes it is a lump on the skin which keeps getting bigger and bigger. More often, cancer grows inside the body where it cannot be seen directly. Cancer is an extremely serious illness, and it should always be treated by doctors. In many cases, doctors can cure cancer entirely, if it is treated early enough. Some kinds of cancer may be caused by smoking too much tobacco. Scientists do not yet understand what causes other kinds of cancer.

Heart disease

Various illnesses of the heart can be severe problems, particularly for older people. Sometimes the illness strikes suddenly without warning, in the form of a heart attack. Most people who have heart attacks can recover, but they may need rest and quiet for several weeks. People who eat too much, smoke too much, or drink too much alcohol are all in danger of having heart disease.

Stroke

In a stroke, people suddenly become unconscious and later may be unable to move parts of their bodies. A stroke is caused by bleeding inside the brain. Sometimes a stroke can cause death or make a person helpless for the rest of his life, but many people recover and resume normal living.

Joints

Many people suffer from pain in their joints, particularly as they become

older. These pains are caused by a large number of different diseases. In most cases, the pain makes the person uncomfortable but it is not really serious. In some cases, the pain is so intense that a person cannot walk or work. In such cases, doctors can often use drugs or introduce other treatment to relieve the pain.

Suggested teaching activities

Discuss with learners—

1. *Health problems which have affected them, their families, or their friends.*
2. *What can be done about these health problems.*

CHAPTER V

Agriculture

Plant nutrition—Plant pests and diseases
Animal health—Selection of seed or breeding animals

A. PLANT NUTRITION

Key concepts: *Plants need nutrients to grow. They extract most of these nutrients from the soil. A farmer needs to replace the nutrients in the soil by using natural or artificial fertilizers.*
Key words: *Nutrients, fertilizer, legumes.*

All living things need nutrients to live and grow. Plants are like people. They need nutrients, or food, to survive. Like people, if plants do not get enough nutritious food, they weaken and become sick. If the nutrient supply is sufficient, crops will grow well and produce high yields.

Where do these nutrients or food for plants come from? The nutrients come from the air, soil and water.

The air contains a small amount of gas called carbon dioxide which is important for plant growth. The carbon dioxide is taken in by the plant from the air through its green leaves and combines with water in the presence of sunlight to produce sugar and starch. This process is known as photosynthesis.

There is not much need to worry about the nutrients in the air as they are abundant, but the amount of soil nutrients for plants is important and causes more concern. Some of the important nutrients plants get from the soil are called nitrogen, phosphorus and potassium. These are taken up by the roots of plants in solution (dissolved in water) to form the building blocks of the living plant, and, therefore, large amounts are necessary for growth. If even one of the nutrients is in short supply, plant growth is

stunted and yields are reduced. There are many other nutrients required for correct plant growth, but in relatively smaller amounts.

The air contains about 79% of nitrogen gas, but only legume plants (such as beans, peas, clover, alfalfa, and ground nuts) can use nitrogen from the air. The legumes are able to do this because of special bacteria which live in small clumps on the roots of these plants. The bacteria can convert the air nitrogen to soluble soil nitrogen. In some countries, legumes are grown and then ploughed under as a source of ground nitrogen for other plants. Plants other than legumes must get the nitrogen from the soil.

As the plants use up the nitrogen, phosphorus, potassium and other nutrients, the amount of nutrients available is reduced. Therefore, to restore nutrients to the soil materials which contain them must be added. These materials are called fertilizers. Animal manures and crop residues (stalks, etc.) are two kinds of natural fertilizer. Artificial fertilizers can also be used. By applying the correct amounts of fertilizers, crop growth can be improved. The plants grow faster and yield more.

Different crops require different nutrients. The amount and kind of fertilizer to be added may depend on the crop, quality of the soil (supply of nutrients already there), and other factors. If plants do not have enough nutrients they cannot grow well, but too much fertilizer may also be bad. For example, if plants have too much nitrogen they may grow tall but produce little grain. It is not easy to plan a correctly balanced programme and a farmer must take note of his own personal experiences. He may also need advice from agricultural agents and scientists in his area.

Suggested teaching activities

1. *Observe two fields of similar crops in which plants in one field are growing better than plants in the other. Discuss possible reasons for the difference. One important reason may be the amount of plant nutrients available in each field.*
2. *Plant two small plots with similar crops. Fertilize one and don't fertilize the other, but treat both alike as far as the same amount of water, sunlight, etc. are concerned. Note the yields, and discuss reasons for any differences.*
3. *Have adult learners examine an empty (or full) bag of fertilizer, or a paper giving instructions on how to use it. Have them determine what nutrients are in the fertilizer, and find out exactly how the fertilizer should be used. They should also read and discuss any safety*

instructions.

4. *Have learners discuss or write about the things farmers in their area are doing to restore nutrients in the soil. Ask if they know of any fields where no fertilizer has been used for many years. What happened to these fields?*

B. PLANT PESTS AND DISEASES

Key concepts: *Growing crops need to be protected from weeds, disease, insects, and other pests. Seeds and other plant products also need to be protected during storage.*
Key words: *Cultivation, herbicides, insecticides, crop rotation, quarantine.*

Every farmer wants to grow a good crop, but he also needs to be concerned with stopping the growth of other things in his planted field. If crops are left untended, they will quickly be choked by weeds or destroyed by disease, insects, birds, mice, rats and other pests.

A weed is any plant which grows where it is not wanted. Grass, for example, may be valuable when it is grown as pasture, but it can be a troublesome weed when it grows in a field of maize, wheat, or other crops. Every plant needs water, nutrients and sunlight. Weeds in a field, or garden, sometimes use the water and nutrients in the soil so that there are not enough left for the crops. If weeds are taller than the crops, they may also block the sunlight. Crops seldom grow well in a field full of weeds.

Every good farmer knows that he must control weeds. The two most important methods of controlling weeds are through cultivation and with herbicides. Cultivation is the oldest and most direct method, in which the farmer cuts down the weeds, pulls them up, or turns them into the soil. Often, cultivation is done with a hoe, but it is also done with a plough or other implements pulled by a tractor or an animal. Such cultivation is hard work, but it is an effective way of weed control.

A herbicide is a 'plant-killer'. It is a chemical substance which kills plants. Two of the oldest herbicides are salt and oil, which have sometimes been worked into the soil to stop plants from growing. Some herbicides kill

all plants, but the most valuable ones kill only certain kinds of plant. For example, scientists have discovered some substances which kill grasses but do not harm beans. If a farmer has a field of beans, he might use a herbicide to prevent the growth of grass. There are many different herbicides, and they work in various ways. Some herbicides only kill weeds when they are beginning to sprout, so these must be used before the weeds sprout above ground. Other herbicides can kill growing weeds and can be applied after growth. Some herbicides need to be applied before the crop is planted. There are many different substances which can be used to help control weeds, but the selection and use of a herbicide is complicated. Most herbicides can also be dangerous to people if they are not used carefully; anyone who uses them should avoid getting them into the mouth, nose or eyes, and should wash away any herbicide which gets on the skin.

Insects can damage or destroy crops. A swarm of locusts can destroy an entire field in a few minutes, but usually the damage is much slower. Crop inspection often reveals some insects on a plant, eating the leaves, sucking the juices, or doing some other damage. There are several different methods of controlling insects.

Insecticides are poisons which kill insects. Some insecticides kill many different kinds of insects, and other insecticides kill only a few specific kinds of insect. Usually, insecticides come in the form of dust or liquid which is sprayed on to the crops. Insecticides can also be dangerous to people so they must be used carefully and safety precautions strictly observed. Plants sprayed with insecticide should not be used immediately after as food.

Another method which helps control insects is for the farmer to remove or plough into the soil the parts of his crop left in the field after harvesting. For example, if a farmer grows maize and picks the ears of grain, but leaves the stalks in the field, insects may have laid eggs in those stalks. Next year, when he plants again, the eggs will hatch and large numbers of insects may attack the crops. Leaving the stalks in the field can be a good way of returning nutrients to the soil, but if insects are a serious problem it may be better to remove the stalks.

Crop rotation is another method of controlling insects. If a farmer grows the same crop in a field every year, he may find that insect damage gets worse and worse each season. On the other hand, if he plants a different crop, the damage caused by insects may be considerably less. Many farmers develop a plan of rotation, for example, growing maize one year, beans the next year and then growing maize again. This does much to prevent insects from becoming a serious menace.

Not all insects are bad. A knowledgeable farmer knows which insects will help crop growth. Instead of eating plants, some insects do not feed on the plants but eat other insects which do. Sometimes farmers even buy or catch certain insects and release them in a field, or garden, to help destroy plant-eating insects. Many birds also aid farmers by eating insects.

Most governments try to protect farmers by controlling the spread of insects. For example, if a new insect is discovered in an area, the government may forbid farmers to sell crops from that area to other areas. Government scientists may be afraid that the new insect (or its eggs) will be hidden in the crops, and carried into other areas. Such a regulation against moving crops is called a quarantine. While some farmers may lose money because of quarantine regulations, others are protected from a new pest.

While plants need to be protected from weeds and insects, they also need to be protected from disease. Plants can become sick, as animals and people become sick. Bacteria can get into a plant and cause infection. No one takes plants to a doctor, but it is important to stop diseases from spreading. One way to do this is to destroy plants which look diseased, before it can spread to other plants. Crop rotation can also help control plant diseases. Some diseases can be treated or prevented by spraying with special chemicals. Farmers can also buy special seeds which are resistant to particular diseases. In certain instances, governments may enforce quarantine regulations to prevent the spread of disease.

In addition to weeds, insects and diseases, plants can also be damaged or destroyed by birds, mice, rats, rabbits or other animals.

In some cases, farmers use special fences or poisons to control these pests. In most cases, however, these animals do not cause enough damage to growing crops to justify worrying unduly about them. Birds, in particular, are often blamed for eating large amounts of grain, when they may really be eating insects instead. Mice and rats, however, are a serious problem with *stored* grain. All food products should be stored in tight containers or buildings which mice and rats cannot enter. Careful disposal of garbage may also help prevent rats from infesting an area.

Suggested teaching activities

1. *Have learners examine containers or instruction sheets for several kinds of herbicide or insecticide. Exactly how should each be used? What will it do? What safety precautions are necessary?*

2. *Get learners to examine a single large plant with care. What kind of insects, insect eggs, or worms can be found? Which ones seem to be doing the most damage?*
3. *Examine a field and determine how many different kinds of weed are growing there. Which weeds seem to be doing the most harm? How can they be controlled?*
4. *Examine two fields growing similar crops—one field with many weeds and a second in which the weeds are under control. What differences can be noted in crop growths?*
5. *Examine a grain storage area. Can you find mice or rats, or signs they have been there? How did they get there? What could be done to keep pests away from the grain?*

C. ANIMAL HEALTH

Key concept: *To be healthy and productive, animals need the right foods, protection from bad weather, and protection from disease.*
Key word: *Veterinarian.*

Many people rear animals for meat, milk, eggs, wool, leather, and other products. These animals include cattle, sheep, goats, pigs, chickens, ducks, geese, rabbits and others. Horses, donkeys, oxen, camels and a few other animals are also raised for use in transportation or general farm work. Most of these animals are reared on farms or open pastures. Some of the smaller animals—especially chickens and rabbits—may also be reared by people living in towns and cities.

It is quite common for people who rear a few animals to let the animals fend for themselves. People with chickens, for example, often leave the chickens to roam about and find whatever food they can. This method may be acceptable to those with only small stocks, but a person who aims to be a successful breeder needs to exercise greater care. The more attention he pays to his livestock the healthier the animals will be. They will grow faster, and be more productive.

Animals are much like people in the things they need in order to be

healthy. They want enough good food. They need to be protected from parasites, infections, and other diseases. They require shelter in bad weather and a clean place to rest with plenty of water and fresh air.

Like people, animals also need good food. Correct diet promotes good growth and better products, both in quality and quantity. For example, chickens left to find their own food, grow slowly, and the meat and egg production is poor. If the owner gives his chickens some extra grain, they will grow faster and products will be of a better quality. Of course, it may be expensive to buy grain for chickens, but the owner can command better prices for higher quality products.

As well as having enough food, animals also need to have the right kind of food. Many animals need some special things in their food. For instance, cattle and most domestic farm animals need salt. If their owner gives them some salt, it helps growth. Chickens and other poultry need the mineral calcium. A lack of calcium in poultry diet produces soft-shelled eggs. Extra calcium can be found in crushed shells or grit.

Animals suffer from sickness. A sick animal may not necessarily die, but may not be productive enough to earn its keep. Often, animals can suffer exactly the same diseases as people. For instance, cows can have tuberculosis, and a person can get the same disease by drinking milk from a sick cow. Many animal diseases, however, do not affect people at all. Many animal diseases are caused by parasites or bacteria. (See Chapter IV, Section A.) To help prevent disease among animals care should be taken to ensure outhouses, barns or stables are as clean as possible. Filth and manure breed disease among animals. It is also important to provide animals with adequate clean water and fresh air. This is particularly important if small animals (such as chickens or rabbits) are kept in cages. If animals do become sick, they can be treated with drugs and other methods just as doctors treat people. Doctors who treat animals are called veterinarians. Sometimes a disease can kill all the cattle or other animals in an entire area. If several animals become sick with the same disease, they should be kept isolated from healthy animals, and a veterinarian should be called in. One sick animal can sometimes pass the disease to hundreds of other animals. In the case of an epidemic among animals, the remedy is sometimes drastic but nevertheless necessary to stop the spread of disease over larger areas.

Animals used for breeding need extra care. When an animal is pregnant, it is particularly important to see that she has enough food and shelter. If the mother is healthy, she stands a much better chance of producing healthy young.

Suggested teaching activities

Discuss with learners (or write about) the following questions—

1. *What kinds of animal do people keep in your area?*
2. *What kinds of food are best for each of these animals?*
3. *How do people in your area protect animals from becoming sick?*
4. *If a serious disease seemed to be spreading among animals in your area, what would you do? Where could you get help?*

D. SELECTION OF SEED OR BREEDING ANIMALS

Key concepts: *If a farmer saves seed from his crop to sow the following year, he should select seed from the strongest plants. In the same way, he should select the best and strongest animals for breeding purposes. The products of hybrid seed or animals, however, cannot always be used from year to year in this way.*
Key words: *Selection, hybrid.*

Every farmer wants to have the best possible crops and animals. One of the most important decisions a farmer must make is in selecting the right seed to plant or the right animals to buy or breed.

Many farmers save a part of each season's crop to use as seed for the next year. This is often a wise thing to do. If the crop has grown well on the farmer's land in the past, then it will probably grow well again. It is safer to use the same seed again each year, instead of experimenting too much with other kinds. Sometimes when a farmer uses a different kind of seed from a store or from another farm, it may not grow well in his particular soil and location. For example, seeds which grow well in a valley farm may not be so productive on higher ground.

If a farmer saves the seed from year to year, he should be careful to select only the best seeds from his crop. In every field, there are some plants which are stronger than the others. Seed from these strong plants will probably produce better plants for the next crop. Seed from weak (or otherwise unsatisfactory) plants may produce weak or unsatisfactory plants. A wise farmer carefully selects the best plants, from which to gather

the seeds.

Those engaged in animal husbandry (the keeping and rearing of animals), in one form or another should practise a similar technique. For example, a person who keeps chickens should select the best strains for breeding purposes. If the hen and rooster are strong and healthy, then these strains are likely to be passed on to the chicks. The weaker animals should be used for food, not for breeding. Sometimes a farmer is wise to buy a good rooster, bull or ram to improve the strain (or quality) of his flocks.

Usually, it is sound practice for a farmer to continue with the seeds or breeding animals that have served him well in the past. However, there may come a time when he wishes to make a change. For instance, scientists sometimes discover, and indeed have discovered, new seeds and new animals which form the foundation for better crops or stronger animals. Scientists have travelled all over the world looking for good seeds and animals. A farmer can only select seed from the strongest plants in his field, but scientists have tried to select seed from the strongest plants in the entire world. Unfortunately, a serious problem is that a kind of seed which grows abundantly in one location may not grow well at all in a different kind of soil or climate. As a general rule, when a farmer believes that a new seed may be good, he should experiment with it. He should get a small amount of the new seed and plant it near his usual seed on a small plot of land. After the two kinds of seed have grown, he can assess for himself which is really better for his farm. Sometimes the new seed must be treated in special ways, so the farmer needs to follow any instructions which may have been issued with the seed.

Scientists try to select the best seeds and animals for breeding, but they also have discovered ways to develop new kinds of seeds and animals. Hybrid animals come from two different kinds of parent. One example of a hybrid animal is a mule, which always has a horse as a mother and a donkey as a father. The mule is a much valued animal for many purposes. It is stronger than a donkey, and it is more steady and sure-footed than a horse. One problem with mules is that they cannot breed themselves—you always have to start again with a horse and a donkey. Scientists and farmers have learned to breed several kinds of hybrid animal. For example, it sometimes happens that mating a rooster of one species with hens of a different species results in chicks which are better than either the hen or the rooster. On the other hand, if a farmer uses these hybrid chicks for breeding, the results may be disappointing in the second generation.

Scientists have also learned to produce hybrid seeds, by combining different species of plants. For example, scientists might find one plant

which has lots of grain but is so tall it droops in the wind. They might find another plant which is short and strong, but which does not produce much grain. Neither one of these plants is particularly good, but a combination of both, scientists find, produces shorter but stronger plants which have an abundant crop of grain. This hybrid plant may be better than either of the original plants. Unfortunately, the seeds from a hybrid plant cannot be saved for use the next year. If the seeds are saved and planted, they may produce plants which are like the original ones—either too tall and weak, or without much grain. If a farmer uses hybrid seed, he needs to buy each year from special seed farms.

Suggested teaching activities

Discuss with learners (or write about) these questions—

1. *How do farmers in your area select the seeds they plant? Do they use hybrid seeds? Do all farmers use the same kind of seed?*
2. *How do people in your area breed animals? Are the animals left alone to breed by chance, or do people try to select the best animals for breeding?*
3. *If you wanted some new kinds of seeds or some new breeding stock, where could you buy them?*

CHAPTER VI

Energy

Different forms of energy—Internal-combustion engine
Electricity—Radio and television

A. DIFFERENT FORMS OF ENERGY

Key concepts: *There are many different ways of doing work. Work can be done using muscle, heat, wind, rivers or electricity.*
Key words: *Work, energy, muscle, engine, electricity.*

For scientists, the word 'work' means making a physical change in something. For example, a farmer who hoes his field is changing the condition of the soil, so he is doing work. A woman who grinds grain or mashes yams is also doing work. A trader who moves his goods from town to town is doing another kind of work.

People say a student is 'working' when he reads a book—and indeed it can sometimes be very hard to read a book and understand it. Scientists, however, are not usually concerned with this kind of work. To a scientist, 'to work' is to produce a physical change in something.

'Energy' means the ability to do work. A person or a thing which is able to do work has energy. For example, a man or woman must apply energy in order to lift a heavy load. An engine also requires 'energy' if it is to set a car in motion.

There are many different ways of harnessing energy to do work. One of the most important ways of doing work is to use muscle. Often, people do work by using their own muscles. For example, many people plough their fields or dig their gardens using their muscles to move a hoe or shovel. Compared to oxen, horses, or some other animals, men and women are not very strong. A horse, for example, can carry a much larger and heavier

load than a man. However, men and women are much smarter than any animal. By using their minds, men and women all around the world have introduced better ways of doing work.

There are many tools which people use to do work. Wheeled carts are an old, but important, tool for doing work. By buying or making a cart, people are able to move much heavier loads than they could ever carry. A person may pull or push a cart by hand, but can move even larger loads over greater distances by using some strong animal to pull it. A truck (or lorry) is basically a cart with an engine, and with this kind of a 'cart', people can move much larger loads over longer distances at great speeds. Man may not be as strong as some animals, but he is clever enough to make and use tools, and those tools make him appear stronger than any animal.

If a person wants to lift a heavy load, he may simply grab hold of it and pick it up. If the load is too heavy for this, there are many tools which he can use to make the work easier. Important tools include pulleys, levers and gears. A bicycle is a different kind of tool, which enables a person to move much faster than he could on his own feet. Even when people use their own muscles to do work, good tools can often make that work much easier and enable it to be completed more quickly.

People and animals both get energy for their muscles from the food they eat. The best foods to provide energy are foods which are either sweet or starchy—especially foods from grains, potatoes, yams, cassava or beans. If a person, or an animal, does a lot of heavy work, they need to eat more 'energy' foods.

Another important way of doing work is with heat. A person uses heat to do the work of cooking food. The heat changes the food to make it tender and good to eat. A person needs added skills to use heat correctly in baking bread, cooking meat, or preparing other foods. The heat does several things to the food, including killing any bacteria in it, but it usually also makes it soft.

Heat can be used in many other kinds of work. Engines which move cars, trucks, buses, motorcycles, aeroplanes, tractors, and many other machines have small, hot fires within an enclosed space. These fires usually burn gasoline, and the heat from the fire makes the engine work. And this, in turn, moves the vehicle forward and backward as desired.

Heat is usually generated by burning something. It can also be derived from the sun, from volcanoes, and other sources. Many people use wood as a fuel, or they may use charcoal (which is made from wood). Another important fuel in many countries is coal, dug from the ground. Petroleum is also found under the ground and under the sea in many parts of the world.

When discovered it can be pumped out and changed into gasoline, kerosene and other fuels. Most of the heat people use comes from wood, coal or petroleum.

In most parts of the world, people have trouble finding enough of these fuels. Sometimes people have been careless or greedy and have cut down entire forests to use the wood as fuel. After the trees are cut, it takes many years for more to grow again. In some cases, after the trees are cut, wind or rain may carry away the soil, so that trees can never grow there again. Many areas which were once covered with trees are now barren and useless.

After many years, trees may grow again, but coal and petroleum once used, will never return. Some scientists fear that the world will run out of coal and petroleum in a few decades. Other scientists believe we will continue to discover enough new fuels to run our machines. In any case, a nation which has coal or petroleum needs to be careful in using it.

A third form of energy which people use to do work is the wind. Some boats are moved by the muscles of people in them, and some boats are propelled by gasoline engines. Many boats, however, use sails to catch the wind, so the wind does the work. On land also, in some areas where the wind is steady, people build windmills and use the energy of the wind to pump water or do other work.

A fourth form of energy can be found in moving rivers. People build special water wheels in a river. The moving water turns the wheel and does work. Giant dams have also been built on rivers, so they can use the energy of the rivers to generate electricity.

Electricity is a useful type of energy. Electricity can produce heat for creating warmth, cooking, ironing or other purposes. It can produce light for people to see. Many machines use electric motors to do different kinds of work, for example to pump water out of a well. Electricity is the motive force, or energy, for operating many things. Some electricity comes from batteries (for example, in an electric torch or a transistor radio). More powerful electricity comes from a central generating plant and is carried along metal wires, known as cables.

Although a form of energy, electricity must be created from some other kind of energy. Sometimes it comes from the energy of rivers. In other cases, the heat from burning coal or petroleum is used to generate electricity. In places where there is no public electricity, people sometimes buy small generators which use gasoline or diesel engines to create electricity.

Suggested teaching activities

Discuss with learners (or write about) these questions—

1. *What are the different ways people in your area use to get energy for cooking? What fuels for cooking are least expensive? What fuels are most convenient?*
2. *If you wanted to lift a heavy load up into a truck, how would you do it? Would you use any tools?*
3. *What kinds of energy do people in your area use in doing farm work? Which kinds of energy are least expensive? Which kinds are able to do the most work?*
4. *Do you ever have trouble getting enough fuel or electricity? Do you believe it will be easier or harder to get enough fuel in the future?*

B. INTERNAL-COMBUSTION ENGINE

Key concept: *Most engines work by burning gasoline (petrol) or other fuel inside a cylinder, creating heat which causes air to expand and move a piston.*
Key words: *Combustion, cylinder, spark plug, piston, exhaust, carburettor, crankshaft, carbon monoxide, diesel.*

One of the most important inventions ever made is the 'internal-combustion engine'. The word 'combustion' means 'burning'. An internal-combustion engine is an engine with a fire burning *inside* the engine. Internal-combustion engines are used in cars, trucks, buses, motor-cycles, trains, aeroplanes, tractors, small electric generators and in many other machines. Most of these engines use gasoline (or petrol) as a fuel.

The most important part of an internal-combustion engine is the cylinder. The cylinder is just a deep, round hole inside the engine. Some small engines have only one cylinder, but most engines have 2, 4, 6, 8 or more cylinders. Generally, the more cylinders an engine has, the more powerful it will be. The cylinder is important because it is the place where the fire burns.

In order to have a fire, you need three things: fuel, air and heat. The fuel

(usually gasoline) is stored in a tank. A special pump (the 'fuel pump') pushes some of the fuel through a small pipe to the carburettor. The carburettor mixes the fuel with air. Then, another pipe carries the fuel and air into the cylinder.

When the fuel and air are inside the cylinder, the only thing needed to make them burn is heat. Each cylinder has a spark plug which makes an electrical spark. This spark ignites the gasoline which burns rapidly, creating a series of small explosions.

But how does the fire make a car or train move? Inside the cylinder there is a piston which is free to move up and down. The piston is near the top of the cylinder when the gasoline burns. The heat of the fire causes the air to expand and this pushes the piston down.

Later, the piston comes back up, and pushes the old air and burned gasoline out through an exhaust valve.

The piston moves up and down, but it is connected to a 'crankshaft'. The crankshaft is similar to a wheel, and the piston makes it go around and around. The crankshaft is connected to the wheels of an automobile or

train, and makes them turn. In some aeroplanes and in boats, the crankshaft is connected to the propeller.

There are, of course, many other parts in an engine and oil and grease are used to keep the engine parts running easily and smoothly. A number of engines, particularly car engines, have water-filled radiators to prevent the engine from getting over-heated. Most engines also have a battery to provide electricity for the spark plugs.

One problem with gasoline or petrol engines is that there is always a gas called carbon monoxide in the exhaust. Carbon monoxide is a poison. If anyone breathes too much carbon monoxide, he may begin to feel sleepy, and he may die if he does not get away from the gas fumes. It is dangerous

to run a gasoline engine inside any building. They should always be used outdoors, where the wind disperses the carbon monoxide fumes.

Many larger machines (especially trains, large trucks, and buses) use a diesel engine which is another kind of internal-combustion engine. It is much like the gasoline engine already described, except that it uses a different fuel and does not have spark plugs. One advantage of a diesel engine is that it produces little carbon monoxide.

Another kind of engine is the steam engine. This is sometimes used in trains or in large ships. A steam engine is an *external*-combustion engine, because the fire is not inside the cylinder. A steam engine uses coal, wood, oil or other fuel to boil water and make steam. Then the steam pushes a piston in much the same way as described above.

One kind of engine used in most aeroplanes is the jet engine. The jet engine works in a completely different way from the engines described above. Electric motors also work in another, completely different way, using electricity and magnets.

Suggested teaching activities

1. *Have learners examine an internal-combustion engine. A small engine (such as on a motorcycle) might be easiest to understand, but you could also use the engine on an automobile or boat. Have them find each of these parts: fuel tank, fuel pump, carburettor, spark plugs, exhaust pipe, cylinder, piston and crankshaft. (Since the cylinder, piston and crankshaft may be deep inside the engine, it may be difficult or impossible to see them without taking the entire engine apart.) A mechanic should be able to show you each of these parts.*
2. *Have a mechanic talk to learners about the things which can go wrong with an engine, and how these things can be prevented or repaired.*

C. ELECTRICITY

Key concepts: *Electricity usually travels inside metal. Electricity can be useful in producing light or heat or in running machines, but it can be*

dangerous.
Key words: *Battery, mains, poles, switch, generator, ground (or earth), volts, short circuit.*

Electricity is a form of energy. One of its most important uses is producing light, from a light bulb or an electric torch. Electricity is also used to produce heat, for example in an electric iron. Electricity can be used to operate pumps, sewing machines, clocks and many other things.

Lightning is a kind of natural electricity. (See also Chapter III, Section C.) Lightning is powerful and can injure or kill people if it strikes them. Electricity can be dangerous, if handled incorrectly. By studying electricity and doing many experiments, scientists have learned how to control this source of energy.

Much electricity comes from batteries. A battery contains acid and other substances. Every battery has two 'poles', usually marked '+' and '–'. In most torch batteries, a metal bump on the top is the '+' pole and a metal plate on the bottom is the '–' pole. Electricity comes out of the battery at one pole, and it goes back in at the other pole.

Unless electricity is very powerful (like lightning), it usually cannot travel through air. Normally, electricity can only travel through metal. Electricity can come out of a battery only if there is metal connecting *both* poles to the same object.

For a light bulb to work, it must be connected to both poles of a battery. Every light bulb has two metal parts. Usually, one metal part is a bump on the bottom of the bulb, the second usually constitutes the base of the bulb. Inside is a special wire which connects one metal part to the other. When electricity goes through this special wire, the wire becomes hot and glows; thus light is produced. Electricity can travel in either direction through a light bulb, but the bulb will not work unless each of the two metal parts is connected to a separate pole of the battery.

If either wire is loose, the electricity will stay in the battery, and the bulb will not light.

Most articles and systems using electricity have a switch which works by disconnecting one of the wires, so the electricity cannot pass through.

If a wire (or other piece of metal) is connected directly between the two poles without a bulb or anything else in between, the electricity quickly escapes. This is called a 'short circuit'. Short circuits sometimes happen accidentally when wires or equipment are old or worn. A short circuit can destroy a battery in just a few minutes. Sometimes sparks are created during a short circuit. (See diagram (g) on page 74.)

If the bulb is connected like this, it should light (provided the bulb is not faulty, the battery is good and the bulb is the right type).

If either wire is loose, the electricity will stay in the battery, and the bulb will not light.

Most articles and systems using electricity have a switch which works by disconnecting one of the wires, so the electricity cannot pass through.

Almost all cars and lorries have batteries: these are used to start the engines. Batteries also have two poles, with a wire connected to each pole. Usually, one of these wires goes to the body of the car, as the metal or the car can serve as a wire or conductor of electricity. When people start a car they turn a switch and electricity from the battery flows into a special motor, called the 'starter'. If everything is working correctly, the gasoline engine then 'sparks' into action. You do not need to use the battery and starter until such time as you turn off the car engine, after which you need to provide electric power to restart it.

If you use a battery for a long time, it gradually weakens and will not turn the starter. This is because all its energy has been used. You can then throw away the used batteries and buy new ones of a similar voltage or

power. Car batteries, however, are different. A car has a 'generator' or an 'alternator' which makes electricity as the car engine turns and transmits that electricity back into the battery. Usually, there is a dial on the dashboard of a motor vehicle which indicates the state of the battery. If the dial points to '–' or 'discharge' this means electricity is going out of the battery. If, however, the dial points to '+' or 'charge' it means electricity is being restored to the battery. If the car is working properly, the battery should last for several years, with current going out, and then being put back.

The strength of a battery is measured in volts. Most torch batteries have a strength of 1½ volts. Most car batteries have a strength of 12 volts.

Electricity from mains is similar to electricity from batteries, except it has a higher voltage. Its strength is usually either 110 or 220 volts. A car battery is strong enough to make someone feel an unpleasant but not dangerous shock. On the other hand, electricity from the mains is powerful enough to injure or even kill a person, if it goes through the body.

Overhead wires carry electricity from generators, which create electricity. These generators, however, are large and powerful. Usually, the generator is powered by either water at a dam or heat from coal or oil. The electricity in the overhead wires is often several thousand volts and it is dangerous to touch these wires in any way. People have been killed because they accidentally touched an overhead electrical wire (or cable) with a pole or some other object. Sometimes these wires fall to the ground during a storm, and then people need to be careful to keep away from the wires and to notify officials to come and repair the cables.

An outlet for electricity from the mains always has at least two holes. Electricity comes out of one hole and goes back in the other. Sometimes, there are three holes and three wires. The third wire is for safety. If something goes wrong (for example, a short circuit), extra electricity is carried away through the third hole, so no one will be hurt. This third hole is connected by a wire to the soil, and it is called a 'ground' or 'earth'.

Electricity from outlets can be dangerous. If a child, for instance, sticks his finger or other object into an outlet, he could be badly injured or killed. Electric mains can also be dangerous if wires are worn out. The metal which carries electricity should always be covered with plastic or other material. If the covering on a wire is broken or worn, the two wires might touch and cause a short circuit. A short circuit can start a fire. Any old or worn electrical wires should always be replaced. Also, people should not put electrical wires across doorways or in other places where someone can step on them or otherwise damage them, cause fires or harm themselves.

Water is dangerous where there is electricity. Electricity can travel through water almost as easily as it is carried through metal. If an electrical wire or an associated device becomes wet, it will often create a short circuit. Therefore, everything associated with electricity *must* always be kept dry.

If too much electricity flows through a wire, the wire becomes hot and starts a fire. All buildings with electricity should have 'fuses' to prevent fires. A fuse contains a piece of wire which melts if there is too much electricity. When it melts, it stops all the electricity. It is inconvenient to have a fuse melt, but this is much better than having a house catch fire. When a fuse melts, it should be replaced with another. If the second fuse melts, there is something wrong with the wiring in the building and it needs to be examined and repaired.

Suggested teaching activities

Have adult learners examine—

1. *An electric torch, including batteries and bulb. Find the two poles on each battery, the two metal parts of the bulb and the switch. Try to see how electricity could come out from one end of the battery, go to the bulb, through the switch, and back to the other end of the battery—always travelling inside metal.*
2. *A truck or automobile, and find the battery (with its two poles), the starter switch, the starter, and the generator or alternator. Try to follow the wires to see how electricity might come out of one pole of the battery, go through the switch and the starter, and go back into the other pole of the battery.*
3. *The electricity fuse box in a building and discuss what to do if the wire in a fuse melts.*

D. RADIO AND TELEVISION

Key concepts: *A radio transmitter changes sound into radio waves and sends them out into the air. A radio receiver catches the waves and converts them to sound.*

Key words: *Transmitter, receiver, antenna, transistor, electron tube, speaker, radio waves, short-wave radio.*

With radios, people everywhere in the world can hear music, news, drama, weather bulletins, agricultural information, and many other items.

A radio programme begins in a station, where men and women talk or play records. The station has a large amount of equipment which changes the sound of voices or music into electricity. Every radio station has a large metal antenna, reaching above the station building. The antenna releases the electricity into the air, in a form called 'radio waves'. Most electricity cannot travel through the air, but radio waves can travel almost anywhere.

Radio waves are weak, and a person normally cannot hear or feel them. There are many radio waves all around us right now, but we must have radio receivers to hear them. A radio receiver catches these waves, makes them stronger, and changes them back into voices or music. Every radio receiver has a metal antenna which catches (or 'receives') the radio waves. In some radios, this antenna is often inside the radio where you might not see it. Sometimes people use large antennas made of wire. If an antenna is large, it is better able to 'catch' the radio waves, so the sound is stronger and clearer. Often, you may need to turn a radio, so that its back or front is facing the radio station and it can catch more radio waves.

Every radio receiver (except some small 'crystal' radios) also has either transistors or electron tubes. Transistors and electron tubes strengthen the weak radio waves.

The third important part of every radio receiver is a speaker. The antenna catches the radio waves. The transistors or electron tubes make the radio waves stronger. The speaker actually changes the electrical waves into voices or music.

Radio receivers also have 'tuners' or 'station selectors'. In the air around you, there are always radio waves coming from many different stations. The tuner lets you select just one station, instead of hearing them all at once.

Most radio waves can travel no more that a few hundred kilometres before they become too weak to be received. Scientists have discovered that small radio waves (called 'short waves') can sometimes travel for many thousands of kilometres. A person with a short-wave radio can 'pick-up' stations in different countries all around the world.

Television works in much the same way as radio, but it requires more complicated equipment. In a television station, both sound and pictures are changed into radio waves. A television receiver converts waves into

pictures and sound.

Suggested teaching activities

Have the learners—

1. *Remove the back of a small radio receiver, and locate the antenna, transistors or electron tubes, speaker and tuner.*
2. *Tune a radio receiver to a station in a city several kilometres away. Try turning the radio set in different directions and listen if the loudness or quality of the sound changes. Find the direction in which the radio should be turned to get the best sound. Discuss how this is related to the actual situation of the radio station.*

CHAPTER VII

Some ideas on teaching science in non-formal settings

Why include science in literacy programmes?

If you stop to think about this for a moment you will quickly realize that science, in one form or another, touches upon the everyday affairs of community living, whether it be in urban or rural areas, at home or at work or even during leisure. It is, therefore, essential to understand the basic facts of science as they relate to life. Literacy classes are one place for teaching these facts.

Quite apart from this, however, the introduction of science in literacy work helps the learner to develop his vocabulary so that he is better able to communicate and think about the world around him. The teaching of science in this nonformal setting is not easy, but it is, nonetheless, desirable. Some basic principles are set forth below.

The learning experience should be related as closely as possible to the learners' life experience. A treatment of soil erosion, for example, should include constant reference to examples of erosion with which the learners are familiar. It should include walks to gullies, wind-eroded fields, wave-eroded coast, or any other examples in the area. The goal is not to teach abstractions about erosion; it is to help adults think about and communicate about the examples of erosion around them. The ultimate objectives should be to enable participants to examine any section of land in their community, identify the important reasons for erosion, predict the changes likely to occur to the land over the next 10 or 20 years, and discuss possible ways of controlling erosion on that land.

Adults already know a great deal about their environment (often more than literacy workers) and this knowledge should be used as a basis for further learning. Rather than telling farmers how to farm, or cooks how to cook, it is usually better to begin by letting learners express what they know. In some cases, such views may seem basically ignorant or even superstitious. If learners express their views on disease, for example, it is likely that many of them will mention causes and cures which are quite

different from those discussed in this monograph. A discussion of mental illness, in particular, is likely to reveal some views which a doctor would term 'superstitious'. Whether you agree with the learners or not, you must still begin with what they know and what they believe. It does little good to tell people new 'truths'. It is more useful to help them think of and communicate about their current knowledge and beliefs.

Concepts usually develop slowly. It can be difficult, for example, for a person to stop thinking of a comet as an omen of disaster and start thinking of it as a bit of rock, ice and gas orbiting around the sun. To take another example, learners will probably never really understand the concept of an 'experiment' unless they have been rather extensively involved in doing some experiments and in reading about experiments done by others (but close to the learners' interests). A single lesson is unlikely to be of much use in developing basic concepts; a continuing effort is needed from initial literacy work through follow-up and beyond.

Whenever possible, new facts or ideas should be introduced through concrete examples. If you want adults to believe that the seemingly clear water they drink from the river contains invisible, disease-causing bacteria, it may be necessary to take a microscope, collect some of the water, and let them see for themselves. Unfortunately (even if microscopes are available) it may prove difficult actually to see the bacteria. Moreover, many adults might find it hard to believe that what they see through the microscope is really an enlarged image of bacteria living in water. The task of clearly illustrating and demonstrating new ideas is difficult but necessary.

Adults should be actively involved in communicating about science, both by expressing their own ideas and understanding the ideas of others. This communication should be in both oral and written forms. It should include communication with peers, with 'experts' and with those who know less than the learner about the topic.

In Chapters II to VI, suggested teaching activities were given for each of the topics. It should not be supposed, however, that these activities need be included in a single lesson on the particular topic. It is probably more effective to develop several topics in an integrated way over an extended period of time. Of course, the nature of such an integrated programme would depend upon the particular situation, but two possible examples are outlined below.

A PROJECT METHOD

Farmers might be involved in a project extending over several months or years to improve their crops. In the early stage, the literacy workers might be primarily concerned with helping the farmers to identify their problems—for example, that maize yields have been declining over the years.

A second stage of the project might involve the collection of additional data—for example, the farmers might make a careful survey of maize fields in the area and of fields in surrounding regions. This survey would inevitably involve some record-keeping, perhaps of a quantitative nature. The survey could cover such factors as soil types and locations (e.g. valley farms vs. hillside farms), cultivation methods, presence of weeds or insect pests, seed types, use of fertilizer, etc.

A third stage might concentrate on the collection of ideas from others. The group might be introduced to typical publications from local agricultural agencies, or to some of the information contained in earlier sections of this monograph. The group might actively seek out ideas, perhaps by approaching agricultural agencies, colleges, research stations, or commercial interests (e.g. fertilizer companies).

Based on the data and ideas collected, the group might next agree on one or more possible solutions to their problems. They might suspect, for example, that their fields were becoming short of nitrogen and that a certain fertilizer might help.

The next stage in the project could be to devise a way of trying out the tentative solution. The group might ask, for example, 'How can we be sure the fertilizer which this company wants to sell will really help?' An appropriate experiment might be designed and carried out on a small plot of land. Detailed records would need to be kept of the experiment.

Based on the experiment, the group might come to a conclusion and perhaps plan another step. They might decide, for example, 'The fertilizer helps a bit, but not enough to justify its cost. Let's try crop rotation with legumes.'

An additional stage in the project could consist of reporting the results to others. One way of doing this might be through an article written for a local newspaper or newsletter. Another might be a report made to students in a local school. (Unfortunately, many schools have little interest in the real world of adults and they are often reluctant to accept that uneducated adults could have something to teach. Still, it is worth attempting to lower the barrier between adult and school education.)

From a report such as this, it is hoped that adults would learn some science and that they might even solve one or two of their problems. The most important benefit, however, could be an increase in the adults' ability to communicate with each other and with people outside their community.

A STRUCTURED METHOD

In the 'project method' outlined above, the aims of the experience were left largely to the learners. In other programmes, the aims are carefully specified by the educators. It might be decided, for example, that the adult learners should:

1. Be able to explain what happens inside a person's body during an infectious disease.
2. Be able to describe the sources of infection most common in his or her community.
3. Be able to demonstrate appropriate methods of avoiding each source of infection.

A sequence of lessons might be designed to achieve these objectives. The first lesson might include a discussion about the diseases which the learners consider most important. It might require a great deal of time to relate the symptoms and disease names used by the learners to the medical terms used by doctors, health workers and in this monograph. It is no good talking of 'tuberculosis', for example, unless the learners can relate the word to their own experience.

Later lessons might concentrate on the causes of disease, beginning with a discussion about the learners' ideas. The discussion should use specific examples from the learners' experience. The literacy worker might next present the idea that many diseases are caused by infection, perhaps using the analogy with snakes and parasitic worms, as in this monograph. The presentation would be accompanied with many visual aids, such as pictures of bacteria and pictures of people drinking unsafe water, and (if possible) the learners would examine actual bacteria from their environment through a microscope. The learners should always be encouraged to argue with the leader about bacteria. They have a right to demand evidence. Indeed it is unscientific to believe in bacteria without evidence.

Several more lessons might be devoted to the causes of specific diseases common to the community and discussions of how they could be avoided. Although the sequence of formal lessons might move on to another topic at

this point, the concept of infection would be re-inforced through other media, such as posters or articles in a local newsletter for new literates.

It should be noted that the objectives for these lessons on infection are stated in a way which goes beyond knowledge about infection—the adults should be able to *express* their understanding. There are at least three reasons for this: (1) no matter how good the lessons were, the teacher can never be certain that the adults actually learnt anything, unless they somehow express what they learnt; (2) the act of expression probably helps learners to understand more clearly, and (3) the adults should now be able to teach others, including their children, about the concept.

The two examples of teaching methods have been outlined briefly because the details will depend upon the particular situation. They are not intended as prescriptions, but only as illustrations that science topics can be dealt with in a variety of ways within literacy programmes.

Within the universe our world is small. It is, nonetheless, mysterious, exciting and even surprising. All of us need to understand it better and to communicate about it more effectively.

CHAPTER VIII

Science in functional literacy

Case Studies from Iran and India in Agriculture and Health

This chapter provides two examples of how science has been included in functional literacy programmes.* Neither programme was intended primarily to teach science. However, science was important to an understanding of agriculture in the Iranian programme and to improved health of mothers and infants in the Indian project. These examples are typical of the role science plays in functional literacy courses. Understanding of science is a means and not an end. It is one of several components contributing to the achievement of a practical objective desired by programme participants: for example, more productive agriculture or better health.

Science and agriculture

The General Agriculture Programme was one of 28 programmes developed by the Iranian Work-Oriented Adult Literacy Project. This project was part of the Unesco/UNDP aided Experimental World Literacy Programme which consisted of projects and activities in fifteen or so developing countries. The particular programme under examination was planned for introduction into villages with diversified agriculture in the Isfahan region in central Iran. Other agricultural programmes were designed to offer guidance in growing particular crops—for example, sugar beets—or agricultural problems such as plant diseases. Although the content of these programmes differed, the principles on which they were designed were similar.

* The material in this chapter was assembled by Jamileh Abhari and Janet Cobb, of the Programme Unit of the International Institute for Adult Literacy Methods.

Three of the four main objectives of the General Agriculture Programme directly involved an understanding and ability to apply science to agriculture:

1. To enable participants to acquire basic skills in reading, writing and calculation.
2. To enable participants to understand modern science and technology and, in particular, its application in general agriculture.
3. To provide farmers who are already experienced in traditional agricultural methods with the knowledge and skill to apply more productive and scientific techniques.
4. To introduce progressively into agricultural practice those improved techniques which are considered applicable, given the situation of particular farmers.

The overall objective of the programme was to improve the social and economic well-being of farmers by enabling them to produce more and thereby increase their incomes and, at the same time, contribute to the increase in national food supply.

In designing the curriculum and instructional materials for the programme, principles similar to those recommended in the previous chapter were applied. These were:

1. To select subjects of importance and interest to participants and their community;
2. To recognize and make use of the adult's agricultural knowledge and experience in the teaching-learning process;
3. To introduce new concepts slowly and systematically, proceeding from concrete examples to general principles and from the known to the unknown so as to make the concepts easily understandable;
4. To present subjects or problems as an integrated whole rather than as knowledge fragments and to direct the programme, in so far as possible, toward the solution of recognized problems;
5. To link all phases of the programmes, such as teacher training, teaching materials and teaching procedures, so as to give the programme a unity, and enable it to achieve its objectives.

The programme was constructed in sequences or teaching units. Each sequence dealt with a selected subject or problem. All together there were 50 sequences in the course, each of which required approximately a week

of class time to cover. The organization of sequences is shown in Table A which presents six of the teaching units. Each unit is indicated within the box. The subject areas and references have been added for the convenience of readers of the monograph.

Each theme consists of five elements: technical knowledge, simple science, socio-economic information, mathematics and language. Although these elements are presented separately in the table used in planning the course, in the teaching-learning process the various elements were merged and dealt with together in the analysis of a problem.

In the third sequence, for example, the problem is low crop yields. One of the possible ways of remedying this problem is through crop rotation. 'Crop rotation' is, therefore, introduced as a *key word.* This immediately raises the question of the planting season and the pattern of rotation and crop protection against insects. It also brings up the problem of estimating yields from fields of different sizes which involves multiplication and division, the principal mathematic content of the unit. The discussion of market demand—part of the socio-economic content of the unit—raises the question of price which calls upon the mathematics and vocabulary introduced in this and preceding units. In discussing crop rotation, the concepts of agriculture science in Chapter V would be discussed. Finally, the technical components would cover the application of these concepts in the Isfahan region. The advantages and disadvantages of different patterns of rotation would, for example, be discussed in relationship to both their scientific and economic effects. Ideally, each of the five components would broaden and deepen the learner's understanding of the problem being discussed. The selection of a practical problem, the solution of which would benefit participants and their community, was intended to sustain motivation, a critical problem in many adult literacy programmes.

It is suggested that the reader study Table A and consider the various ways in which the five components could be combined into exercises which would increase understanding and sustain interest. In the Dezful programme, conducted in a region in south-western Iran, a similar programme was used. There was, however, a sixth component, practical training, which was carried out in demonstration fields. Here, for example, the principle of crop rotation might be tested by the means of conducting an experiment.

The method used in the project was, as can be observed, what has been called in Chapter VII a 'Structured Method'. The objectives are clearly specified, the materials carefully selected and the presentation closely integrated. Provision is made, however, for discussion of problems presented

(*continued on page 90*)

TABLE A—ORGANIZATION OF SEQUENCES*

Examples: Six teaching units (or sequences), each representing a course of one week's duration.

Subject Area: Soil.

UNIT I	
Technical:	Isfahan soil: near mountains, sandy clay; near river, excess sand; small stones; little humus; salty areas need drainage.
Science:	Soil elements: wet clay soil difficult to work; addition of sandy soils needed.
Socio-economics:	Better quality soil produces more abundant crops; soil composition and analysis.
Mathematics:	Percentages to calculate soil composition.
Language: (Key words)	Soil, water, an introduction of the letters which form these words; other key words of constant oral use include weather, wind, sunlight, irrigation, erosion, observe, predict, control.

Reference: Chapter III: The Environment.

Subject Area: Pests and Diseases.

UNIT II	
Technical:	Microbes in soil, decomposition into nitrates, need for oxygen and warm weather.
Science:	Bacteria, microbes and viruses.
Socio-economics:	Soil diseases; harmful to production; transferable to animals and men. Anthrax. Quarantine.
Mathematics:	Weights, measures, calories and time periods. Numbers up to 1,000; simple mental addition and subtraction.
Language: (Key words)	Fertile, fertilizer, an introduction of the letters forming these words; other key words of constant oral use include weather, sun, rain, temperature, moisture, irrigation, bacteria, erosion, pests, diseases.

References: Chapter III: The Environment; Chapter V: Agriculture.

* Each of the sequences is an example of the Structured Method described in Chapter VII. References to other chapters have been included.

Subject Area: Increasing Crop Production.

UNIT III	
Technical:	Crop rotation; examples of rotation of 2 to 6 year periods.
Science:	Crop rotation helps to prevent diseases and leads to better production and regeneration of soil.
Socio-economics:	Rotation for economic benefits; capital; workers; market requirements.
Mathematics:	Year and seasons; uses of metric system; simple multiplication and division.
Language:	Rotation, cultivation, appropriate, classification, diseases, pests.

Reference: Chapter V: Agriculture.

Subject Area: Production.

UNIT IV	
Technical:	Correct time of ploughing; methods dependent on soil and crop to be sown.
Science:	Soil composition; retaining moisture in clay; moisture loss in sandy soils.
Socio-economics:	Hire and use of agricultural machinery; tractors; ploughing; correct use of fertilizers; quantities, etc.
Mathematics:	Volume and cubic measures.
Language: (Key words)	Need, several, more, better, cotton, sow, store, insects, fertilizers.

References: Chapter III: The Environment; Chapter V: Agriculture.

Subject Area: Prevention of Pests and Diseases.

UNIT V	
Technical:	Chemical protection and control through insecticides and pesticides; spraying; quantities and the time to use; safety precautions.
Science:	Life and insects; reproduction.
Socio-economics:	Damage caused by pests and diseases; some insects are good, others harmful. Sandstorms.
Mathematics:	Ratio, division.
Language: (Key words)	Insects, plants, diseases, destroy, surface, solution, powder, safety precautions, skin, eyes, mouth, contact.

Reference: Chapter V: Agriculture.

Subject Area: Correct Use of Irrigation.

UNIT VI	
Technical:	Irrigation: uses, danger of over-irrigation; times and sequences of irrigation.
Science:	Soil and water; water and air in soil; root absorption; water and soil composition.
Socio-economics:	Damage caused by over-irrigation; killing of useful microbes.
Mathematics:	Fractions and decimals.
Language: (Key words)	Waste, think, amount, thirst, cause, loss, water, irrigation, soil, sink, microbes.

References: Chapter III: The Environment; Chapter V: Agriculture.

by the learners and encouragement is given to the learners to discuss personal problems and concerns related to the themes under discussion.

An essential element in the programme was the training of instructors. This consisted of a three to four week pre-service course, followed by weekly in-service sessions. Special emphasis was given to training in the use of discussion techniques and to preparing the instructors to present the scientific and technical content of the programme. As one of the purposes of the programme was to promote communication among learners, it was felt necessary to train the instructors on how to initiate and guide group discussions. This was particularly necessary because most of the instructors were primary school teachers who were accustomed to using lecture methods and rigidly controlling classroom activities. As the instructors had little background in either science or technical subjects, they had to be instructors with the opportunity to receive help on problems which had arisen in the preceding week, and also provided training in the sequence to be structures with the opportunity to receive help on problems which arisen in the proceding week, and also provided training in the sequence to be presented the following week.

The instructor's guide and other teaching materials were prepared to assist instructors with little or no experience in working with adults or in a specialized subject. These materials were of four types:

1. 'Content sheets' containing all information on the technical, scientific, language, socio-economic and mathematical content and principles to be taught;
2. Audio-visual aids, in particular, posters depicting the subjects of problems under discussion;
3. Teaching guides containing systematic information on how the elements presented on the content sheets might be developed and containing instruction on the use of the audio-visual aids;
4. A plan and timetable for the development of the sequence.

These materials were designed to complement the primers and work sheets provided to learners. The instructors were also given weekly tests which enabled them to assess the participants' understanding of the unit.

The evaluation of this programme provided a number of interesting insights. It was felt that the principle of integration of components into problem-oriented or subject-oriented units contributed to motivation and learning. In communities where demonstration fields were established, interest in the programme appeared stronger and rates of adoption of new

practices higher. An experiment with training farmers to serve as instructors or group leaders showed positive results. As might be expected, the farmers required more training in teaching techniques, but were better able to demonstrate farming techniques. It might also be expected that a farmer instructor would have a closer rapport with group participants who were his peers than would a primary school instructor. No information on this point, however, is provided.

One of the lessons of the General Agricultural Programme reviewed is that the successful teaching of science requires careful planning. The relationship of the science component to other course content must be thoughtfully considered. Ideally, the science content—as well as all other content—should contribute not only to participant learning, but to the achievement of such practical goals as increased agricultural production. As noted in the first chapter, this is not an easy requirement to fulfil, but where the programme is well-planned and the necessary conditions prevail, it is possible. Instructors have to be carefully recruited and trained if they are to succeed in teaching the spirit of science as well as scientific facts. Attention must also be given to providing learning materials which are motivating and informative and teaching guides and aides which enable instructors to perform their duties with competence and confidence.

Science and health

The Experimental Non-Formal Education Project for Rural Women* was designed to investigate the most effective way of bringing a basic social package of material and child health practices to the three most vulnerable groups in rural India—pregnant women, lactating mothers and children up to the age of three. The project was conducted in Mahbubnagar, located in the plateau area of Andra Pradesh, one of India's southern states. It is a drought-prone area with a high rate of malnutrition among women and children. It is also a rural area far from metropolitan influences so that the experiment, if successful, could be repeated in other parts of India. The initial phase involved eight villages, and drawing on the experiences gained,

* The functional literacy programme discussed in this section of the monograph relates the basic facts of science, as far as health is concerned, to observed conditions common in remote rural areas of India. The summary is based on 'Curriculum Development for an Experimental Non-Formal Education Project for Rural Women' prepared for the International Institute for Adult Literacy Methods by Dr. Anita Dighe in co-operation with Drs. Prodipto Roy, T. A. Koshy and Victor Jesudason, all of the Council for Social Development, New Delhi.

was later expanded to 22 villages. A third phase will reach 80 villages. The local language Telangana Telugu was used and the programme staff were largely recruited from the district.

The impetus for the project came from the observed facts of life in the region. Early marriage (from age 11) and early pregnancies (average age of 14 for the first child) led to an infant mortality rate as high as 60 per cent for the first child. The practices and beliefs associated with this problem, deeply rooted in the traditions and circumstances of rural life, would not yield to science teaching alone.

Three components

The basic package of integrated services contained three components:

An educational programme to arouse the interest of rural women in problems related to pregnancy and childbirth, and to focus attention on practical and scientific solutions;

A medical programme covering ante-natal, natal and post-natal medical services for mothers and infants;

A supplementary feeding programme to bridge the most critical nutritional gaps, with use of local food as far as possible.

In order to test the most effective way of delivering these services four experimental groups were used: Functional Literacy Classes (FLT), Mother Child Centres (MCC), a combination of the two and an experiment control group in comparable villages with no additional inputs other than the normal government programme.

Target groups were pregnant, nursing and weaning mothers and their children up to the age of three. The people it was proposed to reach were classed as socially backward; about 65 per cent of the families were dependent on agriculture. Female literacy was about 4 per cent, as compared with an overall 19 per cent for India generally. Female workers comprised 40 to 50 per cent of the total labour force which reflected 'the dire necessity for all adult members to work in order to survive'.

It was recognized by the project authorities that an academic approach to teaching health and nutrition would intimidate participants, many of whom had no previous schooling and would thus prove to be ineffective. Research activities were used for two purposes: to help design the experiment in as scientific a manner as possible and to gauge the conditions before and after the experiment in order to document accurately the effects of the project. Teaching was based upon the concrete and observable facts of village life.

Table B on the following page shows the curriculum for the course was derived from the problem-survey which was conducted among village women. Explanations of science-related concepts always began with the familiar and concrete and proceeded only as far as necessary towards the unfamiliar or abstract. For example, the discussion of vitamins, minerals, proteins and human nutrition generally, as presented in Chapter IV dealing with health, was not introduced as such, but examples of food which are rich in these essential ingredients were exhibited at group meetings and methods of cooking to preserve their nutritional qualities were demonstrated. The concept of bacteria was not directly discussed, but the ability of heat—boiling water—to kill harmful substances on the utensils used to feed children, and sterilization procedures were demonstrated. In short, attention was given to providing simple and concrete explanations of science facts and science based procedures. To provide such explanations, the existing conceptions and misconceptions of the participants had to be understood and the content of the lessons had to be expressed in the language which was used and understood in the local communities. Extensive piloting of materials was needed before these requirements were met.

There was no attempt to isolate a subject called 'science' in the instructional materials or class procedures. On the contrary, science concepts were integrated with other needed information to solve the practical problems at which the course was directed. Better nutrition, for example, requires not only new understandings but acceptance and social support for new dietary practices and practical measures to produce more foods of the right kind. Similarly, family planning is not primarily a problem of knowledge and technique but a matter of attitude and social values. Thus, in functional literacy programmes, improved scientific understanding is usually an intermediate objective and a means rather than the final objective of the course. The goal of the programme was improved health among mothers and children, a matter of practical concern which attracted women to the classes.

The classes met for 90 minutes six days a week for several months. Participants were usually seated in a semi-circle with the instructor at the open end. Flash cards rather than a primer were used to present key words and ideas as they were more easily revised and better captured the attention of the participants. As literacy skills were initially low, the explanations of health and nutritional practices were based upon discussion and demonstration rather than written explanations. Particular importance was given to group discussions. Training of instructors was designed to provide guidance on how to initiate and guide discussions and classroom materials

(*continued on page 96*)

TABLE B

	Some salient findings of problem surveys	Problem area	Curriculum content
1.	(*a*) Women married at the age of 11. (*b*) Childbirth started from the age of 14. (*c*) Women did not have any check-up during pregnancy. (*d*) Women had their confinements at home attended by local *Dai.* (*e*) Women experienced health problems following delivery. (*f*) 60% of the first born were dead.	High infant mortality especially among the first-born.	A healthy mother had a healthy baby. (Confirmation of pregnancy, ante-natal care, need for check-up, ailments during pregnancy, warning signs of abnormality, vulnerable periods, etc.)
2.	Women did not take any special or extra food during pregnancy or nursing period.	Malnourishment in expectant and nursing mothers.	Nutritional requirements during expectant and nursing periods
3.	(*a*) Majority of children suffered from or died due to diarrhoea, dysentry or worms. (*b*) Weaning foods were not known or prepared in the community.	High toddler morbidity.	(*a*) Nutrition and health care of infants and toddlers. (*b*) Prevention of communicable illness.

	(*c*) Nanju (Kwashiorkor) and Katta Nanju (Marasmus) were recognized as common occurrences among infants and toddlers. (*d*) With the exception of smallpox vaccination, immunization was not known.		(*c*) Child development and rearing function: particularly early symptoms of Nanju and its steady treatment. (*d*) Prevention of communicable illness.
4.	Correct knowledge on any form of contraception was poor, with very low adoption rates and attitudes to the Family Planning Programmes were negative.	Large family size.	Family planning.
5.	Literacy was very low among the women (about 4%). Education was recognized as a means of employment only.	Illiteracy.	Need for literacy for everday life.

Source: Case Study of Curriculum Development for an Experimental Non-Formal Education Project for Rural Women. Council for Social Development, New Delhi, 1977, p. 28.

were designed to facilitate such exchanges. As noted in Chapter VII, by encouraging adults to express themselves the instructor can be certain that they have correctly understood matters. Also, the act of expression helps adults to understand more clearly and enables them to teach others, including their children, what they have learned. Demonstrations, using the materials available in the participants' homes, showed how the procedures discussed could be actually carried out.

Conclusions

The two examples in this chapter, as well as many others which could be included if space permitted, show that the facts of science and procedures based upon science can be taught successfully and usefully to unschooled adults, even though they be illiterate or semi-literate. Teaching of science or any other subject, however, is most successful when it is related to important and felt problems, such as low agricultural production or infant mortality. Successful teaching also requires that the teacher and those who prepare the teaching and learning materials understand the problem being dealt with both factually and as it is understood by the learners. Before new understandings can be introduced existing ideas about causality have to be understood and dealt with. It is also necessary to express the concepts of science in the language in common use by the learners and to assist understanding by providing examples and demonstrations of important concepts. Particular attention should be given to assisting and encouraging adults to express and discuss the information they acquire. 'Scientific literacy' implies not only the possession of knowledge but its sharing and application.

In proposing that literacy workers and literacy programmes give increased attention to science teaching, we are not seeking to bring science into the already full and sometimes troubled lives of Iranian farmers or Indian mothers. It is there already. The subject of nutrition is nearly as old as the habit of eating. The application of technology to agriculture is as old as civilization. We seek only to offer a better understanding and, where possible, more control over everyday situations and problems through a clearer perception of the scientific facts that can explain them. It is human nature to inquire and innovate. Science and science-based technologies are merely ways of inquiring and innovating more systematically and effectively. They are, thus, part of the heritage and hope of human-kind.